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Alfred Noble

THOSE who did not have the pleasure of personal acquaintance with him will deem much of the praise of Alfred Noble elsewhere in this issue as extreme, as the natural expressions of the grief of those who were thrown in contact with him. But his friends know that the expressions only do him justice. Endowed with tremendous natural ability, he was no less blessed with traits of character that aroused the affection of those who met him. For that reason none can speak of his professional achievements without referring to Alfred Noble, the man. His eminence professionally rested not on achievement in one specialty, but upon his ability to grasp the largest problems, discerning at once the economic as well as the purely technical aspects. These aspects did not, in his mind, clash, but each had a weight instinctively estimated by his fine judgment, once the facts were in hand. Then with remarkable directness he pushed forward to the completion of the work. Upon great bridges, important waterways, difficult tunnels, he has left his impress—monuments to his genius. With the greatest engineering work of his time, the Panama Canal, his name is inseparably linked, as the word of former-President Taft on a succeeding page amply testifies. Before he left, too, his colleagues had shown to the utmost of their powers their appreciation of his ability. Honored as has been no other American engineer—with the presidencies of the American Society of Civil Engineers and the American Institute of Consulting Engineers, with the John Fritz medal, and the Elliott Cresson medal—professional brethren from overseas stretched forth their hands and made him an honorary member of the Institution of Civil Engineers—a most unusual distinction. One of the chief interests of his last years is worthy of and characteristic of the man, his desire to raise the status of the profession. Unceasing was his vigilance to ward off adverse legislation, never faltering his courage when matters of importance were to be presented to high Government officials. His work in the upbuilding of the technical societies with which he was connected will long continue its influence toward the improvement of the engineer's professional status. Yet with all his honors and despite the magnitude and importance of his retainers he never lost his humble, but most dignified, bearing. Approachable, sympathetic, quick to see difficulties and willing to aid in their solution—little wonder that his admirers come back time and again to his human qualities. Well indeed has that man deserved of his fellows who can receive on his departure from this life the encomiums now so generously, and so deservedly, accorded to Alfred Noble.

Reports—Means or an End?

EFFICIENCY studies have been quite common both in industrial and municipal management in recent years. When made by trained men, of analytical ability, they have generally disclosed the reasons for inefficiency and have formulated plans by which the shortcomings could be overcome. Very often—and this is the point to which attention is called—the report itself becomes, in fact, the end of the investigation, even though the managers, upon reflection, realize that it is but a diagnosis and suggested cure. If the report becomes only a shelf ornament, it were better that it had not been made. It should be analyzed, criticized, digested, so that its contents will be fully known to the executive officers responsible for the operations it covers. If such digestion carries conviction as to the soundness of its conclusions, vigorous action is needed; if the conclusions are wrong, either because illogically deduced, or on account of the falsity of the premises, the criticism made here does not lie. One specialist on management has declared the investigation, conclusions and report to be but one-third of the work. The other two-thirds consist of execution. Yet he testifies that in many cases the work never advances beyond the report stage.

Scope of Liability Laws

WITH the amplification of employers' liability laws it behooves every contractor to pay close attention to his responsibilities in this direction and to find out exactly to what extent liability under new laws increases costs. It is also worth while to follow up as closely as possible current decisions interpreting the liability laws that have recently gone into effect. One such decision was recently rendered in a California case, wherein a maintenance man in the employ of a gas company was refused compensation because he was injured not, as it was claimed, while actually employed but between one inspection point and another. The California Industrial Accident Commission, however, awarded compensation and held that employees are under the protection of the act from the moment that their working day begins until it is completed, in the most literal sense. In other words, if a man is sent on an errand off the work in which he is supposed to be engaged and while on such errand is injured, he is entitled to compensation. Under the case in question it would appear that a traveling man would be under the protection of the California act from the time he started for a train until he returned to his home. The actual holding in the California case was that, owing to the roving character of the employee's work, it was continuous and that he was at all times, except when at home, under the protection of the workingmen's compensation act.

Intelligent Interest in the Canal

PROBABLY no other event ever drew the attention of the laymen to the details of engineering so strongly as has the construction of the Panama Canal. The publicity it has received has led to a fairly good understanding of the methods, and, in some degree, of the costs of the work. The broader aspects of the enterprise, too, are receiving much attention. Recently an editorial appeared in the Los Angeles "Times," which analyzed the changes in shipping costs that probably will be incident to the opening of the canal. The figures need not be repeated here, since they have been gone over in various reports and magazines. The mere presentation of the subject in a logical and financially sound way is a gratifying relief from the generalities so customary in discussing the benefits of a work of this order. If that same spirit can be directed to National expenditures generally, the voters—by which yard-stick the bargaining congressmen, senators and representatives alike, measure all legislation—may finally be brought to analyze the efficiency of expenditure of our billion-dollar appropriations. The day of the flourishing pork barrel will then be past, though in a modified form it will probably always be with us.

Defended by Its Employees

AT the annual meeting of the stockholders of the United States Steel Corporation on April 20 there appeared representatives of employees who hold shares, and these representatives, armed with the proxies of their fellows, "stood up in meeting" and defended the policies of the corporation towards its employees. What is the significance of this departure? Is it a freak? Or does it indicate a marked change in the attitude of employee to employer? It should be understood, too, that these employees represented not the office force, but the men in the mills, those at the rolls and the furnaces. If one were to believe stories that were afloat several years ago, as to the overworking of men in the steel plants, the conclusion would be that these employee-defenders of the corporation were traitors to their own interests. Yet there was no suspicion of this, nor charge thereof by those who started the agitation. The singular occurrence on Monday, therefore, must be taken as a vindication by the alleged oppressed of the alleged oppressor. Certainly the officers of the corporation may well take satisfaction from this event, for it is an indication that the "safety first" campaign of the company, combined with its progressive—not sentimental or mushy—welfare work, is impressing itself on the employees. It is a sign of an esprit de corps in the rank and file—where the public did not expect to find it. While it is probably true that the unlettered foreigner may be little impressed by the "safety first" movement, for example, except insofar as it spells only his own safety, his son appreciates the efforts made for his well being. There are "blue devils" enough in the various sinister movements now under way to warrant bringing up and endeavoring to evaluate any hope-giving sign of this nature. There must be readjustment of the employee's attitude toward his employer before industrial peace, or even tolerable industrial conditions, are possible. May we hope that this occurrence is the sign of a dawning day?

The Engineer's Library

IT would hardly seem necessary in this enlightened age to plead for the establishment of well-indexed libraries in engineering offices. Yet the article by Louise B. Krause on page 479 is not written on the basis of surmise but on testimony as to the lack of libraries in some large organizations. Nor is her indignation at the retention by individuals of data belonging to the organization a mere supposition. Many cases could be cited where such is the rule rather than the exception. Certainly ethical standards are low where such is done, nor can the practice be condoned because it is a remnant of the days when the mechanic feared to impart his knowledge to his co-workers lest they supplant him. Men so narrow and with such little consideration of the rights of the organization cannot be trusted to handle in the broadest way and to the best interests of the employer the problems intrusted to them. Their selfishness must inevitably show itself in their work.

Furthermore the employer very commonly is at fault in not providing properly for the arrangement, preservation and indexing of the information. The trouble in these offices frequently lies with the men at the top. They have so long been engaged with the broader engineering problems that they fail to appreciate the value of information regarding details. Consequently the expenditure of money for keeping this sort of information does not appeal to them in the true light, and they dismiss the suggestion of a librarian with an injunction that the office boy or a junior engineer be given the library as a side duty. The consequence is that the accumulating experience of the firm remains in the minds of its employees, or in a mass of manuscript, clippings and pamphlets shelved or filed without system and record—a jumble generally as useless as if it did not exist at all. Certainly the designing data, estimates, cost figures and the thousand and one bits of information that are used in developing the designs for a great hydroelectric station, for example, are a valuable asset if properly preserved. They form in a sense the foundation, the basis, for the structure of design. If what has been here said is granted, the conclusion that a trained librarian be employed is inevitable. On this point, too, Miss Krause adds a valuable suggestion; that in the small organization the trained librarian if not entirely occupied by her specialized duties can attend to other matters as well. The total cost of indexing, therefore, will be in direct proportion to the extent of the library.

Some Observations on Fire Hazard

TO read over the annual report of fire losses in these United States is not a cheerful task. It becomes still more depressing when one compares it with the similar records in other civilized countries. And the worst of it is that the loss is without mitigating circumstances. It is complete, irreparable and inexcusable. Just where the blame should be laid for the frightful conditions which exist in this country is not altogether easy to determine, yet it is quite certain that if the municipal organization for preventing fires were as well organized and as efficiently administered as are organizations for putting them out, the present record would be far less sinister than it now is.

The annual loss of life is more appalling than mere loss of property, yet one can go through any large city in which there has been a fire with frightful mortality and find the conditions which led to it repeated over and over again, unchanged by the latest horror, as they have been unchanged through preceding disasters. Now and then a rookery is condemned as unsafe. If besides being unsafe it is also dilapidated and somewhat disreputable, so that no considerable so-called property loss will be inflicted by its demolition, it is all the more likely to go. One can, however, go through the better sections of any American city and find apartment houses tenanted by the well to do as dangerous at least as any condemned tenement. Such conditions have come about not always through wilful neglect of safety in the interest of cheap construction, but also through changing conditions of municipal growth. A series of detached wooden cottages is not a particularly good fire risk, but is far better than the wooden "three-deckers" that go up when the population becomes slightly more dense, or the cheap brick apartment houses which succeed the wooden "three-deckers."

The time has come, however, when there ought to be united effort at improvement on a very sweeping scale. With the rise in the cost of wood and the experience now available in concrete construction the difference in cost between a tinder box and a reasonably safe building is relatively much less than formerly. Better construction may mean increase of rents, yet there ought to be countervailing savings from lessened fire losses and the charges which have to be made in one form or another against them sufficient to relieve the situation considerably. The main thing is to find some way of getting at and eliminating dangerous buildings, new or old. At present municipal authorities dislike to disturb the supposed "vested rights" of individuals in public dangers. Just because a particular owner has been a menace to his neighbors for thirty years is no adequate reason why he should be permitted to remain a menace for the next thirty years, particularly when those in his condition are a steady and heavy expense to the city in the maintenance of more or less adequate safeguards against the perils for which fire-trap owners are responsible. The insurance companies can and do exercise a good moral influence in improving construction. Why should not a city which is kept in peril, and at the expense of preparing to meet it, charge against the negligent some proportion of the costs now borne by the innocent and guilty alike? If a surtax could be placed on buildings the structure and condition of which render them a menace and a source of expense to the city, there would be a very strong tendency to make fire-traps, old and new, unprofitable. The tax thus raised could very appropriately be charged up to fire protection, the enforcement of suitable building requirements, and the condemnation of structures too bad to be tolerated longer. Only some such drastic method is adequate to deal with the situation, and whatever method may eventually turn out to be best it is high time for municipal reformers to take a hand in saving to the public the huge sums which now annually go up in smoke.

Putting In Foundations under Difficulties

THE value of a structure is often not merely its value considered as an independent separate item, but its value in combination with other structures or in consideration of conditions which it may modify or control. Thus in a serious emergency special construction of very high cost may be not only justified but imperative when a different type or method of construction at a far less cost would be best under ordinary circumstances. Both financial and engineering interests require appreciation of this fact and adjustment of type and manner of construction to the greatest total advantage.

In large cities where buildings command high rentals and the damage from interruption to business is great, speed in construction has a high value and demands high-grade work that must often be executed in an expensive manner. When such work is undertaken without adequate experience, ability and equipment, the result is often disastrous. On the other hand, remarkable results can be obtained by a liberal policy and competent management.

The ability to foresee difficulties, to estimate their importance, to provide for emergencies, to arrange and conduct different operations simultaneously without conflict, to utilize unusual resources and adapt available equipment for special purposes are among the requisites for such work. Sometimes it is necessary to assume a minor risk in order to avoid a major one or to permit a waste in one direction to insure an economy in another. A contractor has been known to deliberately permit a partial settlement and injury to a structure in order to expedite materially the important part of the work and effect a saving much larger than the loss entailed. Such work, kept under absolute control, or work apparently executed at a disadvantage and unnecessary expense, may constitute the most excellent engineering and construction when all of the conditions and results are known.

Foundations on deep rock or in quicksand are usually difficult and costly. Ordinarily they should be constructed under advantageous conditions without interference by other operations or structures. In the case described on page 480 of this issue the reverse was the case. It was advantageous to build them under most adverse circumstances, while a former building on the same site was still occupied and while it was being removed, necessitating work in very limited headroom in the old cellar, obstructed by walls, foundations and mechanical installations. The adoption of an elastic type of construction, the utilization of existing facilities, the efficiency of the plant, and the experience of the contractors, who were able to foresee probable results of various operations involved, made it possible to execute a large portion of the work in safety while the heavy old building was being torn down overhead. The increased cost of executing the work under such conditions was offset by a very material saving of time, and the owners will be able to commence erecting the new steel superstructure weeks earlier than would have been possible if the usual routine had been followed. The award of the special contract and the guarantee of its execution in the limited time show that the importance of the work and its special value were recognized and that the extra cost was probably considered as a profitable investment.

Co-operative Technical Education

THE co-operative courses of the University of Cincinnati are now so well known that no general explanation of the method is needed. Briefly, the plan consists in having the students alternate in biweekly periods between shop and college, the former giving them practical knowledge of the special branch of engineering they are studying, the other, the theoretical side. To one, however, who knows the work by reputation only, a surprise is in store if he visits the university. He finds not merely the same sort of college organization as in other schools, modified only insofar as is necessary to allow the co-operative work to be conducted, but rather a virile educational experimentation plant. The main idea—co-operative education—has ceased there to be a novelty. It is a demonstrated success. Interest centers rather on the detailed problems that the co-operative system has created, which, though inseparably linked with the new scheme, have been given but little publicity. These can, however, be only briefly mentioned here, and the main purpose will be to restate some things already said, but apparently applied by the civil engineer not to his own but to other branches of the profession.

Apparently the shop-college alternation is most easily applied to mechanical, electrical and chemical engineering courses. For this reason, as well as for the greater degree of publicity given to this system through the mechanical and industrial press, its progress is best known to mechanical engineers. It has, however, been quite as successful when applied to the civil engineering course.

While students will be graduated for the first time from the civil engineering course this year, the fact that twenty firms are co-operating in this course—including three large trunk lines—is ample proof that the method is producing satsfactory results,

The interests co-operating include, besides the three railroads, municipalities, a frog shop, a bridge shop, a rolling mill, and contractors in several different lines. The co-operation for the railroad students in the five-year course—all courses are of this length—begins on the track gang. The second year he works with the bridge and building department; the third under the signal engineer; the fourth in frog and bridge shops, and the fifth, on heavy construction. Those specializing in municipal engineering work first as laborers, and then as inspectors on a street gang; succeeding years take them to the sewer, water, and paving departments, while the fifth finds them full-fledged inspectors on any kind of municipal work—and practically always at the full rate of $4 a day. Throughout their practical work their duties differ not one whit, save as inexperience handicaps them, from those of the regular employees. Nevertheless, so close is the co-operation between the school and the employer that the nature of the tasks is such as the school feels is best for the students. They are directed—by syllabi showing what to look for—in their practical work no less than in the class-room and college laboratory.

The college work is so handled that the student is supplied, in advance of his contact with them, with the theory necessary to the understanding of practical problems. When such is not the case, it is held that the course is faulty and readjustment is promptly made. Experience has shown that the meeting with practical problems whets the student's appetite for the theoretical and vice versa. Theory gives him the key to practice; practice elucidates the theory.

Among the innovations which are of greatest interest are the abolishment of all examinations and the rule that students may be conditioned at any time, no matter what their records may show. If, for example, a fifth-year student is unable to solve a given problem through lack of knowledge which he should have acquired in the third year, he is conditioned in the subject, even though his record shows brilliant work therein in the third year. This system is a check not only on the student but also on the instructor, for the deficiency may be due not to the student's forgetfulness or neglect, but to the omission of the matter entirely or its improper presentation. This scheme has brought about considerable readjustment in the courses, so that year by year conditioning becomes more and more the student's fault, rather than that of the instruction.

Space does not permit of discussion here of other features of special interest. They can only be mentioned. The work in English seems almost ideal. The basis consists of descriptions and discussions of the shop or field work of the student. He reports on all his outside occupations, and these reports go first to the English department and then to the technical instructors. His "field English," if the expression be allowed, is thus under constant surveillance; in fact all his written work is subject to the same examination. The result corresponds with optimistic surmise. An additional and most important benefit of this scheme is that during the entire five-years' course the student is learning to write reports, a thing some engineers, to their own loss, never learn.

Incidentally, it may be noted, that practically all of the reports are typewritten (this is voluntary with the students), and many are illustrated by photographs. The latter idea has recently been incorporated into the requirements, so that all civil engineering students are now obliged to secure cameras and illustrate their notes photographically.

Quite different from the developments already mentioned is a most unusual study —the value of psychology in determining capability and adaptability of the students for certain work. This is in line with the vocational guidance studies being made elsewhere. Already some theories advanced by psychologists have been exploded, and a trained psychologist, in conjunction with the dean of the college, is pursuing the studies farther.

The co-operative plan has now been tested long enough, some eight years, to show that it is practical—even more, that it is a success. It cuts down the plant investment by the college enormously, on account of the elimination of extensive laboratories; at the same time it allows men to attend who could otherwise not afford a technical education. Its endorsement by those nearest it, the manufacturers of Cincinnati, is evidenced by their attitude. At its inception they regarded it as the whim of the new dean of engineering, Herman Schneider, and with the greatest difficulty thirteen were induced to open their plants to the co-operative students. Now there are seventy-three firms and interests co-operating, and those companies which do not take the initiative themselves in instituting relations are in a receptive mood when approached. The sponsor of the idea has risen in the estimation of his fellow citizens from a pedagog with a whim to one of the influential men of the community. Examination of his work will convince investigators that he has deserved the position accorded him.

Alfred Noble

ALFRED NOBLE, master civil engineer, universally respected because of his ability, loved and honored by those who knew him, died in New York, April 19. Apparently in vigorous health, despite the attainment of the Scriptural years, he was stricken rather suddenly during the first week in April. On April 9 it was deemed advisable to perform an operation and though he rallied for a a time his condition hardly became encouraging.

Special to the Engineering Record

> I am very sorry to hear of the death of Alfred Noble. He was the dean of American engineers and has left a record of brilliant usefulness upon which it is inspiring to dwell. I had at one period much official relationship with him and came to respect him most highly as a man and as an engineer. His professional advice in respect to the type of the Panama Canal and the security of the foundations of the Gatun Dam was followed by the Government and has been vindicated completely by the event.
>
> WM. H. TAFT.
>
> New Haven, April 20, 1914.

His early career and his experience until the close of his work on the Pennsylvania Railroad's improvements in New York were recounted admirably by Dr. Rossiter W. Raymond, secretary-emeritus of the American Institute of Mining Engineers, when the John Fritz medal was presented to Mr. Noble on Nov. 10, 1910. The Engineering Record reprints below Dr. Raymond's brilliant biography.

Since the close of the period covered by that biography, Mr. Noble has been in general consulting practice, serving also on retainer as consulting engineer for the New York Board of Water Supply. For this service his experience in tunneling, in the building of masonry structures and the examination of foundations proved invaluable. His knowledge of foundations, too, brought him a most important retainer last year from the Federal Government. Great difficulty was experienced in the construction of a drydock at the Naval Station, Pearl Harbor, Hawaii, ending in the eruption of the bottom and the stoppage of the work. Mr. Noble was sent to Hawaii to advise as to the method by which the work should be completed.

Among the other large works which had recently engaged his attention was the enlargement of the Welland Canal, upon which he reported for the Canadian Government, thus linking his name with another of the world's great waterways. The Public Service Commission of the First District, New York, which is building a $165,000,000 subway system, also called him into consultation.

Many honors conferred upon him by his colleagues are recounted in Dr. Raymond's biography. Following his selection for the John Fritz medal, the highest American honor for an engineer, he was selected an honorary member of the Institution of Engineers of Great Britain, a distinction enjoyed by no other American engineer. In 1912 the Franklin Institute awarded him the Elliott Cresson medal.

In recent years he was particularly interested in anything affecting the status of engineers and it was largely through his influence that the American Institute of Consulting Engineers entered so actively into public affairs. This organization within the past year addressed communications to the President of the United States, the Governor of New York, and the Mayor of New York City, urging the appointment of engineers to such public offices as their training particularly fitted them for. Activity was displayed, too, on the licensing of engineers and Mr. Noble, as a representative of the Institute, journeyed more than once to Albany to plead for proper legislation.

Dr. Raymond's biography follows:

Alfred Noble was born in 1844 at Livonia, Wayne County, Michigan, His father, Charles Noble, was a farmer, like most of our pioneer settlers in the West. But he and his fellow farmers made of their adopted State a notable center of intelligence and industry. When Alfred Noble was born Michigan had been but seven years a State of the Union; yet she had already begun that course of material and intellectual culture which soon placed her in these respects abreast of the most favored sections of the country. A splendid public-school system, crowned with numerous excellent high schools and colleges, and a great University represent one of these achievements. What wonder that this farmer's boy, taught in the district free school and the village high school, dreamed of the University, as the gateway to an honorable professional career!

> *Special to the Engineering Record.*
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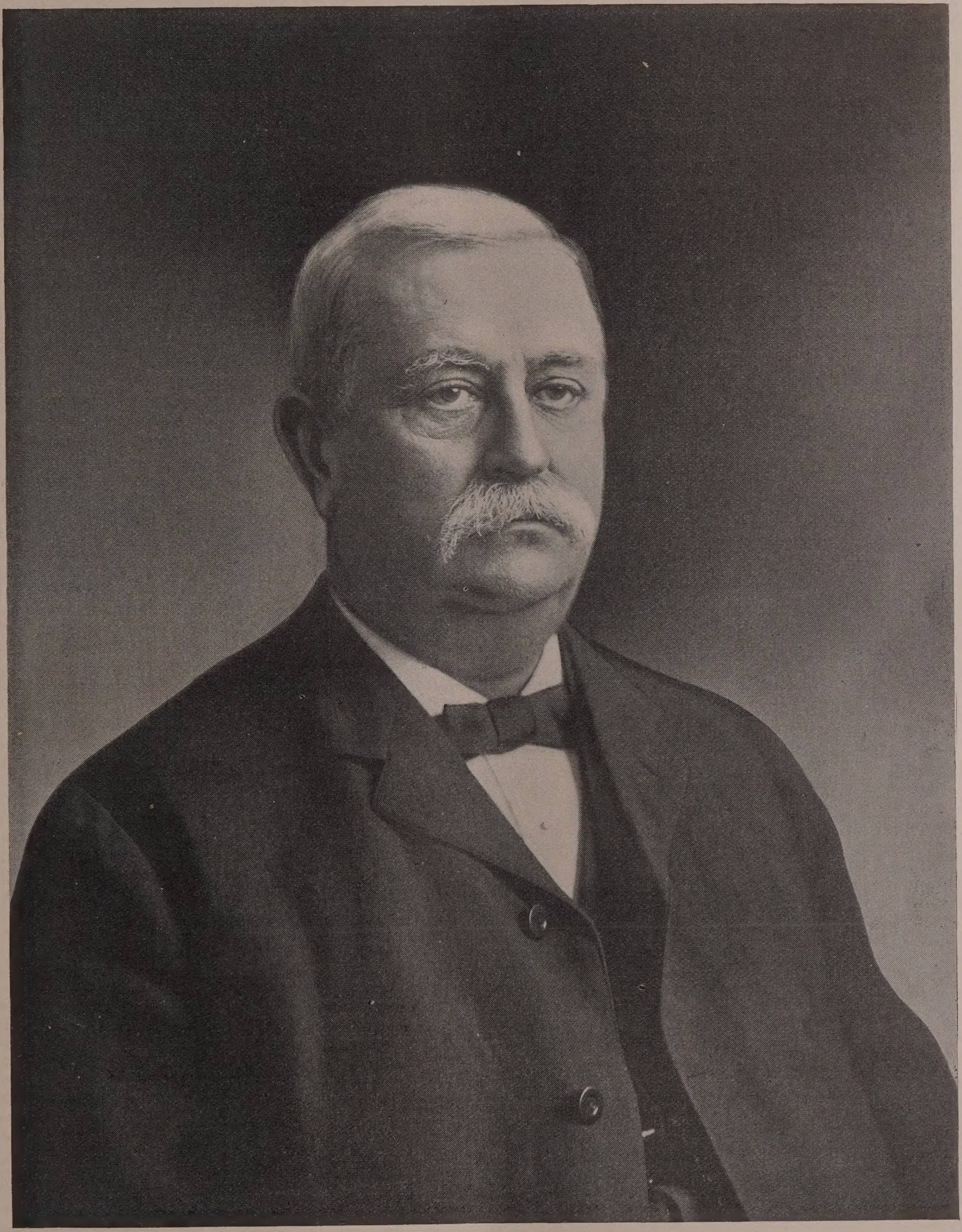
> I have for many years held Mr. Noble in high esteem both as a man and as an engineer. The country is under great obligations to him for his wise and far-sighted course in relation to the Panama Canal. As a member of the International Board of Consulting Engineers, assembled by President Roosevelt in 1905, he threw the weight of his long experience and acknowledged engineering ability in favor of a lock as against a sea-level canal and wrote the report of the minority members of that body, in which the plan of the canal as constructed was outlined. As a member of a special commission of three sent by President Roosevelt to the Isthmus in 1907 to make a special investigation of the lock and dam sites, his signature to a report declaring the foundations safe and stable had great effect in reassuring public confidence.
>
> GEORGE W. GOETHALS.
>
> Culebra, C. Z., April 21, 1914.

Yet in him, as in so many American boys at that time, and, I doubt not, at *this* time, there was one passion stronger than personal ambition—the love of country. When the first call to arms was sounded by Lincoln, Alfred Noble was too young to be accepted. But in August, 1862, when he was eighteen years old, answering the more important call, and volunteering, not for a brief, easy and victorious campaign, but for long, hard service of the Union, he enlisted as a private in the Twenty-fourth Michigan regiment.

Oh, those Michigan farmers' sons, who far from home, and defending not the soil of their own State, but the wider, grander cause of the nation, grimly, loyally, saw the thing through, until the last straight furrow had been plowed and the last field sowed for the harvest of peace! In the West and in the East are the honored graves of a host of them who fell by the way; but not who survived. The Twenty-fourth Michigan belonged to the sorely tested and grandly faithful Army of the Potomac; and through three terrible years Alfred Noble stood with his regiment in the famous First Corps of that army, consolidated, after Reynolds fell at Gettysburg, with the Fifth Corps under Warren. During the first day at Gettysburg, this regiment lost 300 in killed and wounded, out of the 460 who went into the fight. The figures speak for themselves, and what they mean, perhaps only an old soldier fully understands.

At the close of the war, Mr. Noble was discharged with the rank of sergeant, and his patriotic duty having been well done, he resumed the purpose of his youth. His record as a veteran, together with his proved character and capacity, secured for him a clerical position in the War Department, which he filled for more than a year, earning the money, and by diligent use of his leisure time, acquiring the necessary scholastic preparation for a university course. In this way he more than fulfilled the requirements for a freshman, and in September, 1867, he was admitted as a sophomore into the University of Michigan, where he was graduated in June, 1870, as civil engineer. Yet, during these three years, he was obliged to earn his expenses as a student by much outside work, as recorder on the U. S. Lake Survey, as clerk, and afterward as assistant engineer in river and harbor work on the east shore of Lake Michigan.

After his graduation, Mr. Noble continued his work on the harbor surveys conducted on Lakes Michigan and Huron by the U. S. Corps of Engineers, and in 1870 was placed in local charge of the improve-



A Noble

ment of Sault Ste. Marie. This position he retained for twelve years, a period covering the construction of the great masonry lock at the Sault, at that time by far the largest canal-lock in the world. In 1882, after its completion, Mr. Noble resigned his position to become resident engineer for Mr. G. Bouscaren in the construction of the truss bridge over the Red River at Shreveport, La. Early in 1884, he was appointed general assistant engineer of the Northern Pacific Railroad, of which the late General Adna Anderson was then chief engineer. During the next three years Mr. Noble had charge of the building of important bridges, including the truss bridge, with draw, over the Snake River, near its junction with the Columbia, the bridge over Clark's Fork of the Columbia River, the bridge over St. Louis Bay on Lake Superior, and also the foundation and construction of the Marent Gulch viaduct, near Missoula, Montana.

In August, 1886, Mr. Noble removed to New York, to become and remain until July, 1887, resident engineer in the erection of the Washington steel arch bridge over the Harlem River, under the late W. R. Hutton as chief engineer. He then took charge for Messrs. Morison and Corthell of the erection of the bridge at Cairo, on the Ohio River. This brought him into association with the late George S. Morison, whom he served in the erection of the great cantilever bridge over the Mississippi at Memphis, and other bridges at Bellefontaine, Leavenworth and Alton. Mr. Morison's high opinion of his colleague and assistant is matter of record.

It is worthy of note that in this continuous activity of nearly 25 years, Mr. Noble had neither won or sought a newspaper reputation. He had never been advertised as chief engineer of anything. He had merely done his part, loyally and efficiently, in every enterprise with which he had been connected, impressing himself upon his superiors and associates as a man of thorough training, wide experience and absolutely trustworthy character. A reputation thus acquired wears well. Engineers were not surprised when, in April, 1895, he was appointed by President Cleveland a member of the first Nicaraguan Canal Commission. Of Mr. Noble's work in that capacity, and of its important results, I shall not here speak. Nor can I, in the brief time at my disposal, discuss his work as a member of the Isthmian Canal Commission of 1899, which resulted in the adoption by our Government of the present scheme of the Panama Canal. When this subject came up for discussion in Congress, Major W. H. Wiley, a member of the House of Representatives, presented a letter from Mr. Noble, stating clearly and tersely the argument in favor of a lock-canal. This letter was printed in the "Congressional Record," and is said to have influenced decisively the action of both Houses.

But I must go back a little in order to mention what seems to me to be one of the greatest, if not the very greatest, of the engineering investigations with which Mr. Noble has been connected. I refer to the labors of the U. S. Deep Waterway Commission appointed in 1897 to conduct surveys for a deep waterway from the Great Lakes to tide-water. This body spent half a million dollars in its investigations; fixed 21 feet as the most economic depth; proved the most practicable route to be via Lake Ontario and the Oswego and Mohawk rivers; examined by borings, etc., every part of that route, and determined the nature and cost of the work (in every particular except the price of the private property to be purchased or condemned for it) so accurately that a contractor might safely have based his bid for any section upon its report. I have never encountered in the literature of engineering, and I doubt whether that literature contains a discussion so thorough, exhaustive and conclusive. Before that report had been prepared the estimates of engineers—I mean such guesses as engineers sometimes permit themselves to make—had varied by a hundred million dollars as to the cost of the proposed water-way; and it is my impression that even this wide variation did not bring them within a hundred millions of the truth. Be that as it may, the report of this commission, published in 1900, will always remain a monument of professional thoroughness and a model for professional imitation.

THE ENGINEERING RECORD requested expressions from eminent engineers closely associated with Mr. Noble on important works and from former President Taft. Mr. Taft's reply will be found on page 464; the others follow:

By SAMUEL REA

President, Pennsylvania Railroad

It was with the deepest regret that I learned of Mr. Noble's death. My relations with him had been very close for many years during our association on the important New York tunnel work for the Pennsylvania Railroad. He was a man for whom everyone entertained the highest respect—not only for his personal ability and talent but for his modest and lovable personal characteristics. In my judgment the profession has sustained a great loss in Mr. Noble's death.

By E. L. CORTHELL

Consulting Engineer, New York

From twenty-five years of professional association with Alfred Noble my judgment is that, considering all his sterling qualities, he has had very few equals in those solid, reliable traits of character that make for usefulness of a high order to the civil engineering profession and to the world at large.

By J. WALDO SMITH

Chief Engineer, Board of Water Supply, New York

In the entire engineering profession there is probably not another man whose death would be more sincerely mourned than that of Alfred Noble. Above everything, he was a man and beloved by all who came in contact with him, a man to whom everyone in trouble might go and gain something from the wealth of his experience. He was the most conscientious engineer I have ever known. He never rendered snap judgment, even on matters of small importance. Any advice given or judgment rendered was always the result of the most careful consideration. Material things of the world were, with him, always a minor consideration and he repeatedly refused lucrative engagements for the sole reason that he felt that he could not give them the study and the attention which they demanded. His advice was sought not only by the young, struggling engineer, but also by those of wide experience, not in engineering matters alone, but in any matter where experience and good judgment were desirable. He had the greatest breadth of mind and his keenness of vision caused him to see problems in their true light. His acquaintance was world-wide, and his death will be regretted by thousands of engineers who have at some time or other come under his influence. My intimate association with the late Charles L. Harrison brought me into close touch with Mr. Noble and I cannot express by words my appreciation of his influence and of his help. I trust that his influence may live after him.

By JOHN F. WALLACE

President, Westinghouse, Church, Kerr & Co.

In the passing away of Alfred Noble our profession has lost one of its best and highest representatives—the leader in his special work, true to his friends, a gentleman, a man in all that the word implies. He has left a vacancy in our ranks that cannot be filled.

Among other engineering enterprises with which Mr. Noble was connected at this period, I may name the great seawall, built to protect the City of Galveston, Texas, against a recurrence of the disastrous flood of 1900, and the bridge across the Mississippi at Thebes, Ill., which was erected by him in partnership with Ralph Modjeski. Moreover, he has been employed as consulting engineer in connection with the difficult problems presented by the foundations of some of the lofty office-buildings of New York City—structures which certainly need to be planned with more care and knowledge than ordinary architects and builders bring to such tasks.

But the latest of Mr. Noble's labors is also, perhaps, the most important. He was appointed in 1902 a member of the Board of Engineers directing the operations of the Pennsylvania Railroad Company (through auxiliary corporations in New York and New Jersey) in tunneling under the North and East rivers, and under the borough of Manhattan, establishing a great railway-station on Seventh Avenue. The plans approved by this board, and executed under its direction, have been so fully described in recent papers before the American Society of Civil Engineers and the American Institute of Mining Engineers as to need no recapitulation here. Mr. Noble, besides serving as a member of the board, was, as chief engineer of the East River Division of the Pennsylvania, New York and Long Island Railroad, directly in charge of the construction of the tunnels from Seventh Avenue under Manhattan and the East River to the portals on Long Island, the approaches from the east, and the immense terminal yard at Long Island City. This part of the great undertaking is reported to have cost more than $30,000,000. One thing I believe I may safely say—that the difficulties encountered in the quicksands and the decayed and fractured gneiss pierced by the tunnel under the East River were much more serious, though much less widely reported in the newspapers than those presented by the glacial silt which forms the bottom of the Hudson. True to his record, Alfred Noble advertised neither his trials nor his triumphs, but simply finished his work without interlocutory appeals to the public. At the end of 1909, that work being done, he resigned his position as chief engineer. The directing board of engineers, having concluded its work, had closed its offices, and, I believe, ceased to exist six months earlier. Such a quiet, business-like, unboastful termination of a colossal engineering enterprise was worthy, in its simplicity, of the great men who planned it and the great men who carried it out.

Perhaps I may be allowed to say that, in this particular work, Mr. Noble came nearest to the heart of us mining engineers. For several years he and his associates made of New York and its vicinity one of the greatest mining camps in the world. True, in all their tunneling they were only making a hole—not extracting gold or silver or copper from it. Yet, can we say more for most of our mining tunnels? Do they not too often leave us with the hole only as a net result? After all, we mining engineers do not control the commercial results of our borings and excavations. Yet we are often unjustly held responsible for such results, and we cannot but congratulate this mining engineer, whose employers ask only that he shall put his job through and will look for their dividends afterwards, not to the contents of the hole, but to the use of the hole itself. In other words, Mr. Noble has been, in this work, an ideal mining engineer, unhindered by the assayer, the millman, the economic geologist, the mining law or the stock market. We greet him, not without a touch of envy, as our brother!

In this connection let me voice the opinion of mining engineers as to the manner in which Mr. Noble conducted, under land and sea with the minimum of disturbance to the surface, his extensive operations. Some of us (I among the number) have suggested from time to time, with the freedom of those who were not responsible for the results, ways in which this work could be still more quietly and safely done. But all of us agree that in these respects such work never has been better done and we have sense enough to admire and praise the man who directed it.

Mr. Noble's merits have been recognized in various ways by those whose judgment he would most highly value. In 1895 his university conferred upon him the honorary degree of Doctor of Laws, an honor which was repeated in 1904 by the University of Wisconsin; in 1898, he became president of the Western Society of Engineers; in 1903, he was elected president of the American Society of Civil Engineers (of which he had been made a junior in 1874, and a member in 1878). His membership in the ancient Institution of Civil Engineers of Great Britain certifies his professional standing abroad. And we have elected him a member of the Engineers' Club of New York City in testimony that he is not only an eminent engineer, but a congenial companion and a true friend. Yet I fancy that not one of these distinctions—perhaps not all of them put together—will outweigh in his esteem the honor conferred upon him to-night, with the hearty professional approval, and the personal esteem and affection of American engineers!

RECLAIMING LAND along parts of the bay waterfront in Oakland, Cal., will cost, according to a recent engineering report, on an average of $4,000 per acre. This involves the filling in of areas ranging from tide flats to a level 5 ft. below low water, and assumes the use of suction dredges for taking material from adjacent shallow bottoms.

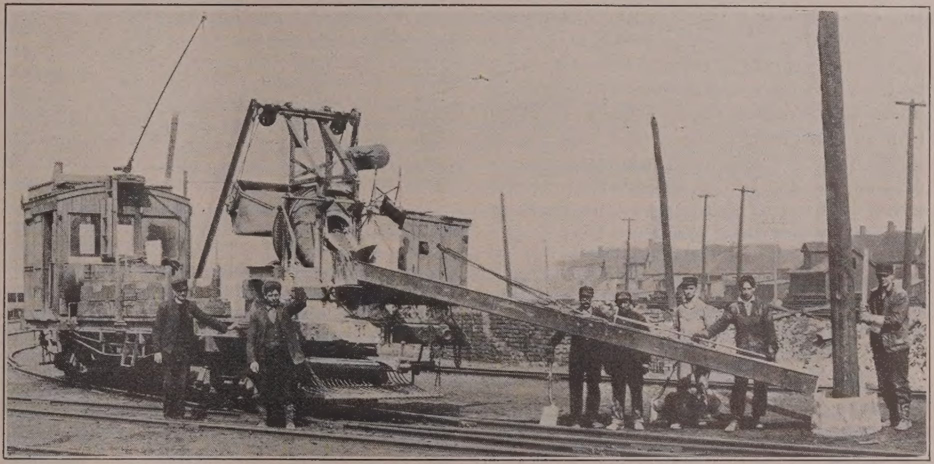
Reinforcing Decayed Poles

Description of Mixing Plant Mounted on Flat Car by Which Cost of Placing Concrete Around Butts of Poles Has Been Cut in Half

By A. J. PURINTON

General Superintendent, East St. Louis & Suburban Railway

A CONCRETE-MIXING car has for some time been used by the East St. Louis & Suburban Railway for mixing and placing concrete at the butts of decayed wooden poles, and has materially reduced the cost of such work. Wooden poles are most susceptible to decay at the ground line, and although a pole might be in good condition otherwise it will finally break at that point. The Orr system of applying concrete to strengthen the pole at its weakest point has been in use by the railway company for some time. Previous to building the concrete-mixing car, material for the reinforcing was loaded on a work car and transported to the site, where the concrete was mixed and placed by hand. It was found, however, that for reinforcing either a small or large number of poles the cost of doing the work in this manner was so high as to make it almost prohibitive. In order to lower the cost it was decided to place a small mixer on a work car. This equipment comprised a 40-ft. double-truck flat car with removable sides, at one end of which an 8 ft. square cab for housing the control apparatus was provided.



Movable Mixing Plant for Concreting Pole Butts

The mixer, a No. 0 special Marsh-Capron, is mounted on the rear end and set as high on the car as overhead clearance conditions would permit, thus giving a vertical drop of about 8 ft. from the spout of the mixer to the rails. This mixer is driven by a General Electric 1000 motor through reduction gears, and both motor and gears are inclosed in a weatherproof housing. To eliminate the variable speed of the motor it is converted from a series to a shunt-wound, and the speed of the mixer is 20-21 r.p.m., making its capacity 6 cu. ft. per minute. The motor operating the mixer is controlled by the motorman from the cab.

A 200-gal. cylindrical tank is mounted directly behind the cab. Air from the brake reservoir, admitted to the tank through a reducing valve, maintains a constant pressure of 10 lb. From this tank the water is forced through piping to a small measuring tank on top of the mixer. This measuring tank is automatic in its action and can be adjusted to measure out any given quantity of water. In addition all the material necessary for a day's work can be carried on the car. The skip of the mixer, when lowered, lies flat on the deck so that material may readily be shoveled into it.

The mixer discharges into a chute 18 ft. long and 10 in. square, open along the top to permit the use of scrapers should the concrete fail to flow. The chute is pivoted at the mixer and supported at the discharge end by a guy, thus allowing it to be raised or lowered, or swung to either side of the track, as conditions may require. With a few exceptions this chute is long enough to reach all poles on the system on either side of the track, and has sufficient fall to allow the concrete to flow by gravity.

Since this car has been in operation it has been found that the cost of concreting a pole has been reduced by half or more, while from two to three times as many poles may be reinforced in a day as was formerly accomplished by the hand method.

Winnipeg Water Supply Line

SATISFACTORY progress is reported in the preliminary work for the new water supply for the city of Winnipeg, Canada, to be obtained from the Lake of the Woods. Advantage has been taken of the frozen ground to make accurate surveys and locate the line approximately on the preliminary alignment through a country almost impenetrable except in winter. A section 37 miles long has been run between two points 38 miles apart, with a deviation of not more than 3 miles from the air line and with a perfectly uniform grade of 0.7 ft. per thousand except for two small river crossings.

The location is through a country about 60 per cent of which is covered with small timber. Half the distance is in muskegs. The concrete aqueduct will be uniformly covered by a fill 4 ft. deep, and it is believed that the invert will at all points be in hard ground below the swampy stratum. A contract of about $1,000,000 has already been awarded for the construction of 96 miles of standard-gage service track for the construction of the pipe line. This track will be built in accordance with standard specifications and will have 60-lb. rail on rock or gravel ballast, qualifying it for permanent service. Construction has already been started on a $25,000 telephone line connecting the engineering and construction camps with the offices in Winnipeg. James H. Fuertes, of New York City, is the consulting engineer.

Drainage System for the North Side Minidoka Irrigation Project

Remedial Measures for What Has Become a Crucial Problem in Irrigation Work—From a Paper Read by F. N. Cronholm, of the U. S. Reclamation Service, before the Idaho Society of Engineers

THE Minidoka project in Idaho contains approximately 64,000 acres of gravity land. The project is bounded on the south and southeast by Snake River, on the west and north by a large bench, some 25 ft. higher in elevation than the project proper. The land is practically level north and south, having depressions in places along the north boundary at an elevation nearly the same as the water surface in the river during low water. All of the land slopes gently toward the west at a rate of nearly 1 ft to the mile, excepting the extreme northeast portion, which has a westerly slope of 1½ ft. per mile. Judging from the topography, which is somewhat irregular, the project evidently was once a wind-swept plain. Due to the prevailing westerly winds, the ridges and depressions run east and west, especially so in the south half, which is the portion in need of drainage. The slope of the river is somewhat less than that of the land; so on an average the land is about 12 ft. above the river in the southwest and 16 ft. in the northeast end.

SOIL AND GROUND WATER CONDITIONS.

Roughly speaking, the surface soil of two-thirds of the entire project is sandy and contains little silt or clay. The major portion of the remaining one-third has a surface soil of sandy loam or light clay, which ranges from 3 to 7 ft. in thickness. These heavier soils, as well as the rest of the project, are underlaid with a porous sand and fine gravel. The stratum of sand and gravel is from 20 to 30 ft. thick and is underlaid by a thick layer of clay practically impervious to water.

The underground drainage in the southern part has become overtaxed, so that about 16,000 acres are now in danger. The area endangered is not seriously affected by alkali except in spots, although it probably would have to be abandoned unless drains now in course of construction are extended to a depth penetrating the sand and gravel subsoil. Of the 16,000 acres, 5500 in 1913 could not be cultvated by reason of water-logging.

CAUSES OF SEEPAGE AND NEED OF DRAINAGE

The topography of the project, being generally flat, has aggravated the seepage conditions and made the need of drainage pressing. All storm water and water wasted by settlers have had to find their way out through the soil, there being no natural outlets.

The slight slope of the project resulted in the construction of canals having light grades and consequently low velocities. In order to raise the water high enough for lateral outlets, the canals had to be built well above the average ground surface and the water surface maintained at nearly bankful level during irrigation season.

The sublateral system was built by the farmers and consists of long, small ditches carrying water under a system of practically constant flow during the middle of the irrigation season, irrigation heads being generally less than 1 sec.-ft. The canals and laterals having been constructed in this manner and mostly through coarse material, the resulting seepage losses have naturally been heavy.

It is realized that seepage losses cannot be definitely analyzed, as the losses in the sublaterals have not been determined independently. However, such losses on the south side of Minidoka project are about equal to the main-canal losses. This is also true of other projects, but any assumption regarding this is dangerous. The only analysis at present possible is for the year 1912, as follows:

	Acre-ft.
Total amount of water diverted	314,000
Total lost in canals	96,000
Amount diverted from canals	218,000
Amount of plant life (basis 2 acre-ft. per acre)	74,000
Losses in laterals and irrigation	144,000

This amount of 144,000 acre-ft. and the 96,000 acre-ft. equal that lost in 1912, or a total of 240,000 acre-ft.

Taking the years 1911 and 1912, and using the assumption that 2 acre-ft. are enough for plant life and that there were 32,800 acres irrigated in 1911 and 37,100 acres in 1912, we have a total of 139,800 acre-ft. consumed by plant life. As the amount diverted during the two years was 628,400, the percolation into the subsoil evidently was 488,600 acre-ft.

Prior to 1911 it is rather difficult to determine the amount of percolation since the first year of irrigation, but it is assumed that smaller areas irrigated have probably resulted in lesser losses on the land and from sublaterals, and that main-canal losses have averaged the same as during subsequent years. Therefore, up to 1911 728,000 acre-ft. were lost and during the seven years just past approximately 1,500,000 acre-ft. have percolated into the subsoil, or sufficient to cover the entire project 24 ft., or to raise the water table 75 ft.

The drains constructed to date average, for twelve months, 40,000 acre-ft. runoff, so that up to date the area of high-water plane has been confined to the 16,000 acres before mentioned. Assuming a rise of ground water of 1 ft. over 15,000 acres to represent the approximate change of water table from October, 1912, to October, 1913, we show an increase of ground-water storage of about 5000 acre-ft., which, together with the runoff by way of drains, makes a total accounted for of only 45,000 acre-ft., against an estimated flow into the ground of 240,000 acre-ft. This further goes to show an excellent but overtaxed system of natural underground drainage, which at present provides an escape for 195,000 acre-ft.

The application of water by subirrigation has been practised in sandy soils almost from the time irrigation first started. While the application of large quantities of water resulted in bringing the capillary water up sufficiently close to the surface for plant life in most places after two years, there were nearly 1000 acres to wet for profitable farming. In subsequent years these areas spread and other tracts became inundated, so that now about 5500 acres are unfit for cultivation. While there may have been exceptions, the largest single factor mostly responsible for the substantial progress of the project has been subirrigation. The greatest difficulty that first had to be overcome was the seeding of sandy soil. As winds are frequent and occur both during spring and fall, it was found trying for the farmers during the first few years. After the ground water was raised within capillary distance of the surface the moisture held the surface soils together and prevented their drifting.

While this practice of subirrigation, or of raising the ground water by pouring large quantities of water into borrow pits and depressions, resulted in bringing the ground water so close to the surface on about 1000 acres after two years of irrigation that the land could not be profitably farmed, it made it possible to farm all of the higher and more level lands, which otherwise were difficult to seed because of blowing sand.

Subirrigation is still practised on the more level lands around the center of the project, as well as in the northeast portion, so that about half of the irrigated area depends fully on the ground water for moisture for plant life, while one-fourth of the irrigation area has the ideal combination of subirrigation and flooding—the surface water being maintained at a level requiring only two or three surface waterings. The remaining portion of the irrigated area is watered mainly by flooding.

DRAINS

A system of surface drains was started in 1910; the construction of this system was discontinued in 1912, although in 1911 a few deep drains were started; since 1912 deep drains only have been built.

The surface drains connect borrow pits along canals and follow depressions through the southern and eastern parts of the project; while these shallow drains do only local good and have no far-reaching effect, they provide excellent runoff for storm water, and to a marked degree control the ground-water level in certain localities. Where the location of surface drains does not agree with that of proposed deep drains the shallow drains will be used as feeders.

As an illustration of the beneficial effect of shallow drains, it may be well to cite the results obtained by 5.5 miles of drain in the eastern part of the project. During the irrigation season, or for a period of seven months, this drain removes approximately 8 sec.-ft., flowing continuously. Figuratively speaking, if the escape provided by this drain was shut off for seven months, ½ ft. of water would be standing over the entire 1800 acres tributary to the drain. This drain, having an average flow of 8 sec.-ft., averages 1.45 sec.-ft. per mile of drain, while the average for shallow drains is only 0.96 ft. The average for drains having a mean depth of 10 ft. below the ground surface is 2.33 sec.-ft. In brief, while the ground-water plane is only little higher than it was a year ago, alkali is showing up in many places ahead of the deep drains now in process of construction, emphasizing the importance of deep drainage.

The low velocities necessarily obtained because of the slight slope of the project and the relation of the river elevation to that of the land encourage water-loving growths to accumulate in the bottom of the drains. It will not be surprising if within the next few years such growths as cat-tails are found growing in abundance. Another matter complicating the maintenance problem are sweet clover, Russian thistle and other weeds that move about during the windy fall and spring months and which invariably find lodgment in the drains. Further, excessive uses of water along the drains will in time tend to fill in the bottom by overtaxing the voids so that the material on the slopes will be carried into the drain and eventually fill it up. This is especially true when water enters the drain on the slope above the water in the drain, causing small streams to trickle down along the slopes.

Location and Depths of Drains

The factor of primary importance in determining the system of drainage which is being followed has been the stratum of loose sand and gravel underlying the surface soils. Drains spaced from 1 to 1½ miles apart, and built to a depth of about 10 ft. below the average ground surface and penetrating the subsoil of sand and gravel, will satisfactorily drain the land, provided an economical and proper method is adhered to in applying the water.

In order to determine the proper location and depth of drains on the project, wells were sunk at each section corner throughout the affected area and on section corners of lands adjacent. These wells assisted in ascertaining the movement of ground water. Readings are taken every two weeks and the readings of each well plotted separately. Water-contour sheets are also made each month from these readings. These sheets greatly assist in observing the change of the ground water table from month to month over the entire project.

Later additional wells have been sunk for the purpose of watching the ground-water surface in parts of the project where drainage may later be necessary. In the northwestern part of the project, where it now seems probable that drainage may not be needed, the fluctuation of the ground water is taken from the local farm wells.

Progress at Panama

THE illustration on the front cover of this issue shows the condition of the Culebra cut of the Panama Canal on Feb. 1. The dredges are at work deepening the canal prism at the Cucaracha slide. The photograph is from the official files of the Isthmian Canal Commission at Washington and is available through the courtesy of Major F. C. Boggs.

View of Hotel Vancouver as It Will Look When Completed

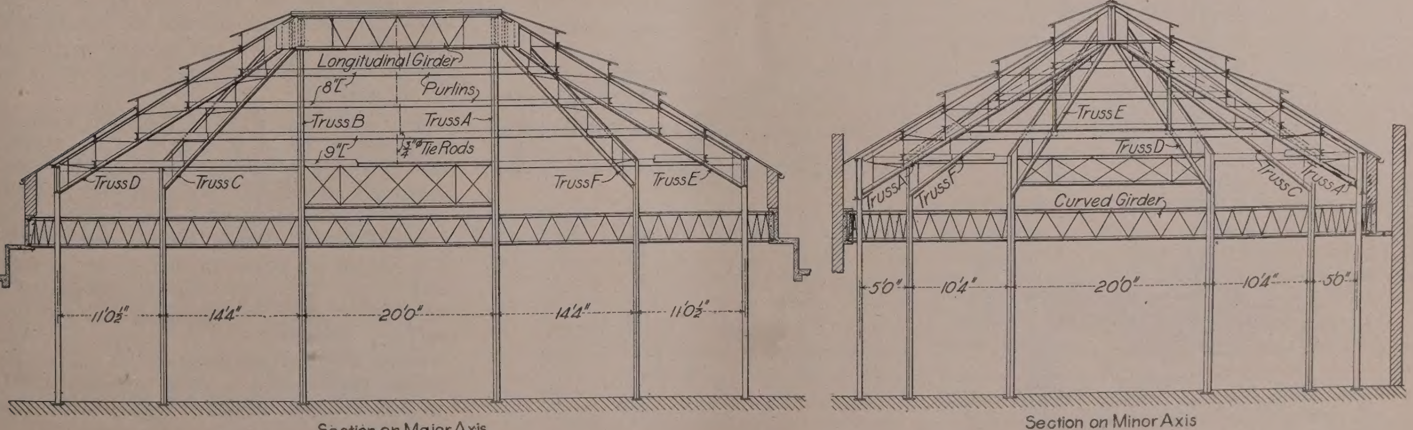
Structural Features of Hotel Vancouver

Fifteen-Story Structure with Inclosed Fire Escape, Suspended Projection from Fourteenth Floor and 52 x 76-Foot Elliptical Roof Frame

THE hotel which has long been maintained by the Canadian Pacific Railway at the intersection of Georgia and Granville Streets in Vancouver, B. C., has been inadequate for some time, and early in 1913 work was commenced on the new 15-story structure which will soon be completed on the old site. The original wood-frame building had been from time to time extended by additions until it covered an area of about 60,000 sq. ft., on most of which the structure stood five stories high. In designing the new hotel limitations were put on the work by two conditions: First, a city ordinance had just been passed placing the maximum height of buildings at 120 ft. with the allowance of a tower eight stories higher covering one-third the ground area; and second, the railway company required that the business of the hotel should not be interfered with during the construction period.

It was found, after considerable study of conditions, that the city ordinance would not cut down the desired capacity nor necessitate an undesirable appearance of the finished structure if a multiple-wing arrangement was adopted affording a series of roof levels that could be graded to relieve the sheer drop of the walls. The accompanying illustration, which shows the resultant architectural effect, should be considered in the light of the fact that out of a total of 500 guest rooms only 44 are provided with windows which open on an inner court without a view. The requirement that hotel service be continuous was met by demolishing only a part of the old structure to begin with, providing temporary passageways, etc., while the new office, lobby and a large block of guest rooms were completed. It is expected that the first part of the new structure to be finished will be ready for service about July 15, 1914.

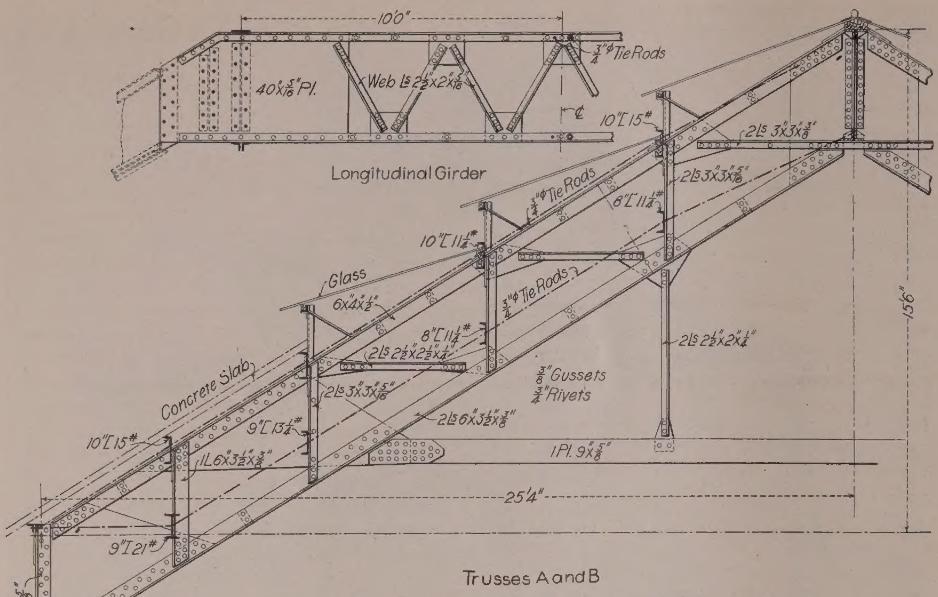
Although a steel frame has been used throughout in the skeleton of the central portion, all columns and floor beams are armored with concrete, this coating being nowhere less than 2 in. in thickness. The stairways, floors and all other slabs are made of reinforced concrete, primary importance being given to the necessity of



Section on Major Axis

Section on Minor Axis

Longitudinal and Transverse Sectional Elevations of Roof Framing of Elliptical Tea Room



Enlarged Vertical Cross-Section of Tea-Room Roof

making every unit in the frame entirely fireproof. The outer wall surfaces will be faced with brick and ornamental terra cotta, topped by an elaborate cornice on the fifteenth floor. Above this cornice will show the pillars of the roof garden pergola, intended to harmonize in the general architectural scheme. No unusual problems were met with in designing the main portion of the building, but three special features were introduced which are worthy of note, namely, the fire-escape towers, the elliptical tea-room roof framing and the fourteenth floor overhang.

As originally laid out, the plans called for open fire escapes built within recesses in the front and side walls of the structure. However, this so seriously interfered with lighting, room arrangement and architectural appearance that special study was given this detail and an entirely different plan devised. The octagonal towers shown in the illustration embody the idea finally developed and have, it is claimed, many advantages over the open-shaft system. A considerable money saving secured by the revision was the affording of two additional rooms on each floor, or a total of 30 rooms added to the capacity of the hotel at a value of $6,000 per room. Although both the wall area required and the total cubical contents of the building were reduced by the revised plans, there was effected an increase in the size of the rooms, and windows were all opened on the main face of the building unobstructed by the iron grillages of fire escapes.

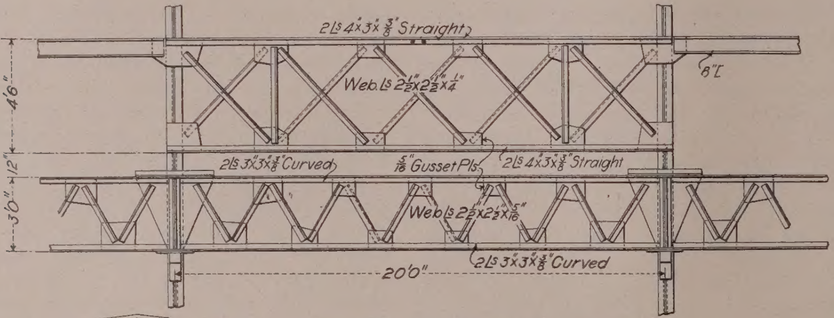
As for the safety features of the tower system, it is claimed that by virtue of being isolated from the building the danger of fire is far less than in the system where all windows front directly on an open escape. The towers are monolithic reinforced concrete shafts having the side adjacent to the building anchored to and supported at each floor by reinforcing rods, the main support, however, being a foundation of steel girders on the first floor level. The brick facing is supported on shelf angles at each floor.

The stairs within the tower make a complete turn in the three five-step flights which are placed between floors, and the use of a triangular platform between flights eliminates spirals, making all flights straight. The stairs are 4 ft. wide, and the central space, 3 ft. 8 in. in width, brings the total interior width of the towers up to 11 ft. 8 in. The rate of descent in the towers is one turn for each story and from three to five windows are provided in each turn. Iron gratings are fitted in these windows instead of glass so that in the event of a fire within the tower, the tendency toward an upward draft will be relieved.

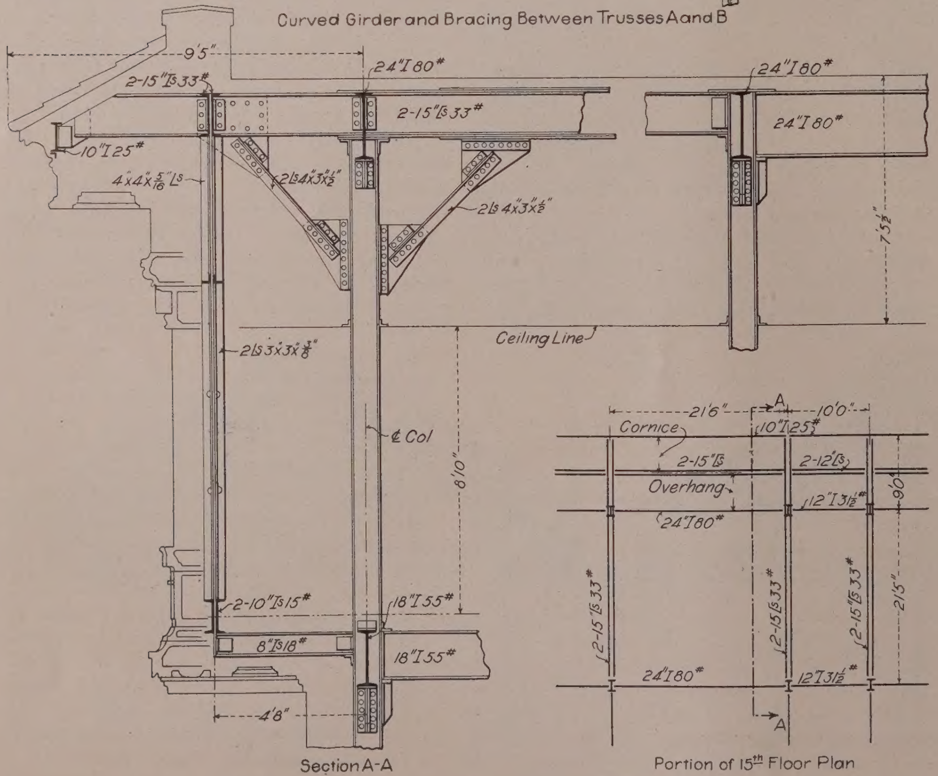
TEA-ROOM ROOF-FRAMING

The tea-room is lighted by means of a glass roof paneled in 5-ft. sections and supported on a steel truss system. The columns carrying this steelwork are placed in the periphery of an ellipse with major and minor axes of 76½ and 52½ ft., respectively. At an elevation of 16 ft. above the floor a latticed truss curved to the shape of the ellipse runs from column to column, tying the steelwork together. This curved girder is embedded in a 9-in. concrete wall, slightly exceeding the girder in depth. The glass ceiling is supported at a level about 5½ ft. above the top of the curved girder and in order not to cast any shadow on this glass, all the steelwork above it has been kept on edge as far as practicable. This idea is carried out notably in the tie beams of the main trusses which are 9 by 5/8-in. flats.

While the steelwork of the roof frame is symmetrical about both axes of the ellipse, the spacings between the individual columns are necessarily not uniform, and the curved girder is calculated to equalize any irregularity in stress which may result. The maximum curve in this girder is such that in the 20-ft. end span its center line is deflected 2 ft. 9 in. from the straight line between supports. Throughout the roof trusses, the purlins parallel the chords between the curved girder supports. The purlins are tied together with five lines of 3/4-in. sag rods, running at right angles to the longitudinal girder at the roof peak



Curved Girder and Bracing Between Trusses A and B



Section A-A

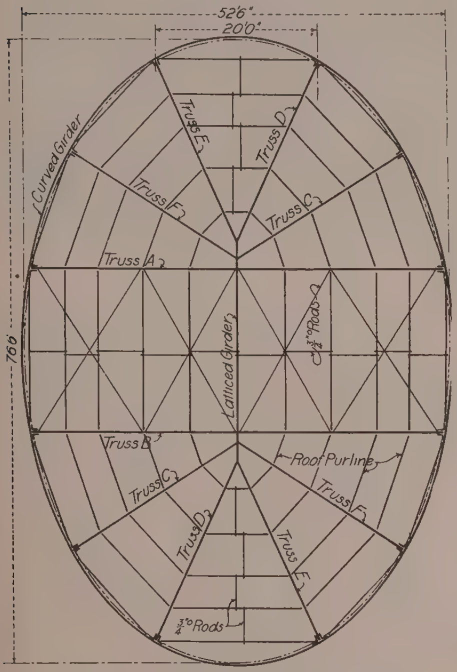
Portion of 15th Floor Plan

Structural Details of Fourteenth Floor Overhang

and keeping within the plane of the roof. Below the three glass roof-panels shown in the illustration, the roof consists of a 2½-in. concrete slab built up on Hyrib.

Fourteenth Floor Overhang

In working out the desirable floor spacing with regard to the total height of the building, it was found that there would be a space of about 7½ ft. between the ceiling of the fourteenth story and the floor beams of the fifteenth. It was therefore decided that this space could be advantageously used by angle bracing, which would make possible an overhang supported from the projecting ends of the fifteenth floor beams. It was figured that this overhang, combining with the weight of the heavy cornice, would tend to balance the fifteenth floor load. Accordingly the arrangement of members shown in the accompanying illustration was adopted. The portion of the fourteenth floor which overhangs is carried by double channels running parallel to the face of the building and supported on vertical angles attached to the fifteenth floor beams. These channels are held at the proper distance from the main columns by 8-in. I-beams. The vertical angles which carry the channels also carry the 14-ft. height of brick and terra cotta wall. This works out so that the 15-ft. 9-in. length of wall dependent from a single fifteenth floor beam has a total weight of approximately 57,000 lb.



Plan of Tea-Room Roof Framing

The ceiling of the fourteenth story consists of a 3-in. reinforced concrete slab hung from the fifteenth floor beams. Embedded in the under side of this slab are 16 by 16 by ¾-in. iron plates spaced about 7 ft. apart both ways and attached to ⅝-in. hanger rods which run up to convenient fastenings in the concrete of the fifteenth floor.

The new Hotel Vancouver was designed by Francis S. Swales, of Painter & Swales, architects. C. S. Millard, H. Thomas and H. E. Gall, of the architects' engineering department, had charge of the calculations and detailing for the structure. The contract for the construction is held by Skene & Christie, of Vancouver, B. C.

River Regulation and Control in Antiquity

Address by Sir William Willcocks, Builder of the Assuan Dam, Before the National Drainage Congress at Savannah

RIVER regulation and control is not a modern art, as the ancient Babylonians were by no means entirely at the mercy of the Euphrates. The address of Sir William Willcocks, builder of the Assuan Dam, at the National Drainage Congress at Savannah, Ga., this week was a history of flood protection from the earliest times in Babylon and Egypt. The lessons he thinks these ancient works point out are thoroughness, combination and continuity.

The earliest civilized communities of whom we have any knowledge, says Sir William, lived in the practically rainless deltas of the Nile and the Euphrates. The early inhabitants of the Euphrates valley called their own cultivated lands "gardens of Eden." The Nile valley they spoke of as "the garden of the Lord, the land of Egypt." The success of their agricultural undertakings depended then as now on perfect irrigation and complete control of the rivers, and though basin irrigation in one and perennial irrigation in the other were their greatest achievements, the control of the rivers was mastered with no weak hand. Early in the world's history, Noah's flood had taught men that though they could say of their rivers that when the good gods had dug them out they had set prosperity on their banks, still these same streams were terrible instruments of punishment to those who failed to combat successfully the dragons which lived in their waters.

Earliest River Control

The earliest river control of which we have any certain knowledge was the work of Marduk, the greatest of the Babylonian deities. The Babylonian epic of creation describes how Marduk first overcame the dragon and then mastered the Euphrates.

Sheltered by solidly constructed and well-protected banks, lay the garden of Eden, a wide stretch of alfalfa, planted thick with date palms, between which were festooned luxuriant vines. The trees of life were there sheltering the garden and the forbidden fruit of the vine. The garden was irrigated by free flow through openings in the dikes. This free flow is in Genesis mistranslated. The primitive gardens of Eden, stretched along the banks of the river, and, protected by dikes, prevented the floods from reaching the pastures where the shepherds tended their sheep. Disputes between the agriculturists and the shepherds were as old as the feud between Cain and Abel. The bursting of a dike destroyed Cain's crops, but benefited Abel's pastures, and on such occasions the Lord had respect to Abel's sacrifice, but had not respect to Cain's.

Complete Control of the Euphrates

The ancient Babylonians completely controlled the Euphrates by means of powerful escapes into depressions in the Arabian deserts. These depressions covered 650 sq. miles and were 25 ft. deep when full of water. In addition to these reservoirs they had the low-lying Pallacopas branch of the Euphrates which took off from above Babylon and discharged the waters of the river into the Chaldean marshes. The first public work Alexander the Great undertook in Babylon was the excavation of a new head on solid ground for the Pallacopas, known some years ago as the Hindia branch, and to-day the main stream of the Euphrates. Its head had hitherto been in sandy soil, and as the branch had to be opened in very high floods to escape the excess waters of the Euphrates and then immediately closed after the flood to keep the main stream full of water past Babylon, the closure had been a work of extraordinary difficulty, entailing the presence of 10,000 men. Next to building a masonry barrage this was the wisest thing he could have done.

The lands of the lower Euphrates, which were exceptionally fertile and supported a dense population, were protected by banks 100 ft. wide. Their remains can be followed to-day along hundreds of miles.

Provided with escapes into depressions in the deserts whose contours can be followed for scores of miles by the presence of thick belts of Euphrates shells, with regulation at the head of the Pallacopas branch and with broad and majestic dikes well protected by brushwood, the Euphrates was thoroughly controlled, and we do not read of any disastrous inundations on its banks. The lessons learned during the terrible flood of Noah's time had been engraved on the minds of the Babylonians by a diamond pen. This local flood on the Euphrates has been magnified into a world-wide disaster by the mistranslation of a single word. In the ancient as well as in the modern language of Mesopotamia "desert" and "mountain" are expressed by the same word.

Part Control of the Tigris

The Tigris enters its delta at Beled, north of Bagdad, over the ruins of one of the most interesting works of antiquity. In ancient days some giant—local tradition says Nimrod—barred the valley by a massive earthen dam, raised the river some 40 ft. and turned it over the hard conglomerate, so that it could flow at a high level and irrigate the whole country. The left-hand canal was the Nahrwan, which had three heads, was 400 ft. wide and 16 ft. deep, and had a length of 250 miles. This work existed for more than 3000 years and was only swept away in the time of the last feeble caliphs.

Though the ancients harnessed the Tigris for irrigation, they never controlled the floods of this river as they had those of the Euphrates, and there were occasional inundations when the dikes were burst, which spread such ruin and disaster, that no records exist of certain years except the dismal tale that the Tigris had burst its right bank. The whole right bank of the river was protected by a broad canal with high banks, known for the greatest part of its course as the Nahr Melcha or the Royal Canal. The most powerful kings of Babylonia were proud to record the fact that they had strengthened and fortified these banks. The Tigris floods relieved themselves by overflowing the left bank of the river, which was abandoned to them.

The perfect control of the Euphrates, where massive dikes were supplemented by escapes into the deserts, and the imperfect control of the Tigris, where double banks without escapes into the deserts failed to provide absolute protection, teach the lesson that protecting dikes unaided by works of sub-control higher up the streams are not of themselves sufficient to insure the lower reaches of rivers against inundations in years of exceptional flood.

CYRUS AND ALEXANDER

Cyrus the Great controlled the Gyndes, a tributary of the Tigris, in a truly original manner. Babylonia was already peopled and lands were needed for his Persian troops. The Gyndes discharges 40,000 sec.-ft. and runs 30 ft. deep in a sandy and mobile bed. He could build no regulator, so he dug thirty canals, divided the waters of the river among them, closed the river by an earthen dam, and completely controlled it. As he could never have induced his wild soldiers to dig these canals for any useful purpose, he took advantage of the fact that his favorite horse had been drowned in the flood and urged his soldiers to dig the canals and dissipate the waters of the river in such a fashion that it could never again drown a horse. One of the canals bears even to-day the name of "Khorassan" from the far distant province in the east of Persia, which supplied the contingent of troops which had dug it.

Alexander's historians record that before his navy could sail up the rivers he had to have the dams across them removed. Such dams on considerable streams were in those days made of earth, and they consequently completely cut off the supplies. Every drop of water at the time of low supply was used up for irrigation. But not only were the waters of the main streams, like the Tigris and the Euphrates, and of secondary rivers like the Gyndes, controlled by earthen dams, but small tributaries like the Adhem were barred by imposing masonry dams where they issued from the hills, and the water led off into canals excavated on both banks. Whatever water issued from the Persian hills into the delta of the Tigris and the Euphrates was utilized for irrigation. Alexander was so struck by the possibilities of the delta that he was planning to rebuild the tower of Babel and make Babylon the capital of his world when death overtook him while he was personally conducting the drainage of the Chaldean marshes.

In the neighboring kingdom of Persia, masonry dams at Shuster and Ahwaz on outcrops of sandstone on the Karun River and opposite Ahwaz on an outcrop of the same rock on the Choaspes, the river of Susa, controlled those streams and allowed the summer supply to be utilized for irrigation. Each of these streams discharges more than 120,000 sec.-ft. in flood.

THE NILE

The Nile in flood does not carry one-fifth the sediment that the Tigris or the Euphrates does, and consequently the transverse slopes in Egypt away from the river are only one-fifth as steep as those in the other delta. If the Nile breaches its banks in flood, it can be brought back after the flood to its old channel without any serious difficulty, while a very severe breach on the Tigris or the Euphrates has been followed by the river completely leaving its channel and forming a new one many miles away. Though flood protection in Egypt is not of such imperious necessity as in Mesopotamia, it is still a matter of no small importance, and its great value did not escape the able men of the ancient world.

CONTROL OF LOWER VALLEY

Menes protected the left bank of the Nile with dikes and probably treated the right bank of the river as the Babylonians had treated the left bank of the Tigris. It was Amenenhat of the twelfth dynasty who put the whole Nile valley under cultivation, constructed the dikes on both banks, and provided the Nile with an escape into the wide and deep depression of Lake Moeris. This escape was one of the seven wonders of the Greek world. They led the flood into the depression when it was dangerously high and provided for its return to the river when the inundation had come to an end, so that the reservoir might be empty when the next high flood came. The gigantic dikes of entry and exit were only cut in times of emergency and were reconstructed again at an expense of labor which even builders of pyramids considered excessive. By cutting the dike in a year of ordinary or low flood the level of the Nile in lower Egypt could be lowered to such an extent that a famine became inevitable, and it was the capture of the dike by the king of Upper Egypt which produced Joseph's famines and its recapture by the king of Lower Egypt which brought them to an end. The Nile shells which mark the limits of the ancient Lake Moeris tell their tale like the shells which lie round the Babylonian depression.

A MIRACLE EXPLAINED

On the approach of the red water of the Nile flood the weaker branches of the Nile were closed by earthen banks some distance above their mouths to allow the flood freely to inundate the country; and it was the shutting off of the fresh water and the entry of the sea water into the tail reaches which killed the fresh-water fish in myriads just as the red flood came, which misled unscientific observers into thinking that it was the red water which killed them. And, indeed, it was local knowledge and skillful manipulation of these same means which enabled Moses to extricate the Israelites with a high hand and overwhelm Pharaoh's host in the Serbonian bog or the "River of Reeds," mistranslated the "Red Sea."

The lessons taught by the Nile controvert the fact that all reservoirs constructed for flood control must be empty at the beginning of a flood, so that they may be fully available for withdrawing water from a dangerously high flood. Moreover, if they are not to be obliterated by silt they should be only used when absolutely needed.

Between the second and first cataracts the Nile is trained by gigantic spurs which advance boldly into the stream and insure a deep channel for navigation in the lowest stages of the river. These spurs have been constructed with care and have top courses of roughly dressed stone which has stood for thousands of years.

RIVER JORDAN

Egypt is practically free of malaria and the Euphrates delta is not scourged by it, but there is one valley in the old world which has never been fully developed owing to its prevalence, and that is the valley of the Jordan. The waters of the Jordan are too low for irrigation, but the valley is full of beautiful and copious springs, which are generally more of a curse to the people than a blessing, as wherever there is a spring of water there are mosquitoes and malaria of a very malignant type. That the ancients had some idea of the value of fish in keeping down mosquitoes and malaria seems likely from the fact that the fish-god Dagon was worshipped in the low-lying malaria-haunted valleys and plains. One can easily see how it was that before Joshua's crossing of the Jordan a severe earthquake displaced a spongy shoulder of Mount Gilead, which slid across the valley, while Jordan fled and the mountains skipped like rams and the little hills like young sheep, and the walls of Jericho crumbled on their base.

The well known cases of river mismanagement or control, such as Noah's flood, the years of plenty and famine in Egypt, and the passage of the Red Sea and the Jordan, were events which in our day we should call natural, and whose courses able men among us on the spot could trace or predict. The ancients saw divine providence in everything, whether it were the fall of a sparrow or the achievement of a human being—and for all we know they might have been nearer the truth than we are, for "there are more things in heaven or earth than are dreamt of in our philosophy."

LESSONS TO BE LEARNED

The lessons to be learned from the river regulation and control of the ancients are writ large over all their undertakings. Thoroughness, combination and continuity. The further we go back in the world's history the more thorough was the work. They designed and constructed like men who realized that they had thousands of years before them. While divergent interests had kept them apart they had so often drowned each other out in one valley and starved each other out in the other that self-preservation made them combine. The world, moreover, was young then and the works were pursued year after year and decade after decade without any racing against time. And it is extraordinary how effective and durable were their undertakings. Their works so struck the imagination of after generations that these latter could only conclude that there had been giants in the earth in those days.

America to-day, in her effort to control the whole valley of the Mississippi, concludes Sir William, possesses resources of a higher order than Egypt and Babylonia possessed to control the Nile and the Euphrates, and if she means to succeed has their example before her. They teach the necessity of a comprehensive project for the length and breadth of the whole valley, capable of thoroughly controlling the river, drawn up without reference to immediate finance. As funds become available, the works can be carried out in order of urgency and importance, whether they take years or decades of years. The experience gained each year will be available for the next to help in selecting the most suitable works; and she will have taken a road lit at every step by sound science, whose goal is the insurance of millions of happy homes in this truly pleasant land. And her children's children, when they contrast their lives free from the destructive floods and wearying fevers of which their chronicles tell them, will unconsciously imitate the dwellers in the old-world valleys of the Nile and the Euphrates, and will say that of a truth there were giants in the earth in those days.

Outfall of Fifty-second Avenue Sewer before Removal of Forms

Costs and Methods of Building Large Sewers

Abstract of Paper Presented at Annual Meeting of Illinois Society of Engineers and Surveyors at Peoria, Jan. 28, by H. R. Abbott, Assistant Engineer, Sanitary District of Chicago

PRACTICALLY all of the work described in this paper—which deals with construction methods and costs for large concrete and brick sewers—is built in good stiff blue clay, in the Sanitary District of Chicago. The improvements are all of recent date—some are still unfinished—and include 12 x 14-ft. plain and reinforced-concrete sections on West Thirty-ninth Street, 7-ft. and 7½-ft. brick sewers and reinforced-concrete conduits as large as 16 ft. in greatest dimension, on South Fifty-second Street. The total length of the sections described is about 17,600 ft.—10,000 ft. in brick, 5320 ft. in plain concrete and 2280 ft. in reinforced-concrete. The latter part of the article is devoted to a discussion of cost-keeping methods. All the tables given cover field operations only, but overhead charges are discussed in the concluding portion of the paper.

WEST THIRTY-NINTH STREET CONDUIT

One conduit, 12 x 14 ft. in size, of elliptical section, was built in West Thirty-ninth Street, from Western Avenue to Robey Street; thence south to the west arm of the south fork of the Chicago River. The total length is 2346 ft., of which 1868 ft. are plain concrete and 478 ft. reinforced concrete, the reinforced section being under railroad property. Connection was made at Western Avenue with a conduit of similar section, extending north in Western Avenue to the main channel of the Sanitary District. The conduit was designed to discharge from 100 to 200 cu. ft. per second. It has a 1:1000 grade, and the flow line is about 3 ft. below crown.

Excavation was started at the Western Avenue end in open cut. A Bucyrus 70-ton steam shovel, with a 1¾-cu. yd. dipper, was mounted on five 16 x 18-in. timbers, 30 ft. long, with two 2-in. truss rods to each timber. The trench width was 15 ft. 8 in. and the average cut 23 ft. 6 in., making an excavation of 13.7 cu. yd. per running foot. On account of the deep cut, the shovel was equipped with a 36-ft. boom and a 54-ft. dipper handle. As there was liability of slides and cave-ins, the excavation was handled in two lifts. On first run the shovel excavated the top 10 ft., using 9-ft. sheeting with one set of bracing placed about 6 ft. below the ground surface. The shovel dug ahead of the finished cut from 75 to 100 ft., then backed up and excavated the lower 13½ ft. The lower lift was taken out between steel beams, each built up of two 10-in. I-beams with cover plates, 50 ft. long, held in place by screw-braces set 7 ft. back from each end. This replaces the ordinary wooden bracing and allows a free movement of dipper in the trench for three moves. When a section is finished, the beams are carried ahead by the dipper, the wooden braces are replaced on the top sheeting, and another set of 9-ft. sheeting is placed with two sets of braces for the lower portion of the trench, the lower end of sheeting being at a point where the invert curve meets the side wall.

The average progress on the plain concrete section per day of nine hours was 30 ft. for both shovel and mixer. This means 420 cu. yd. of excavation, with disposal in backfill or spoil bank. The actual costs of excavation, backfill and spoiling for plain and reinforced sections are given in Tables 1 and 2. The concrete averaged 2½ cu. yd. per linear foot—a daily average of 75 cu. yd. The average progress per day on the reinforced section was 24 ft.

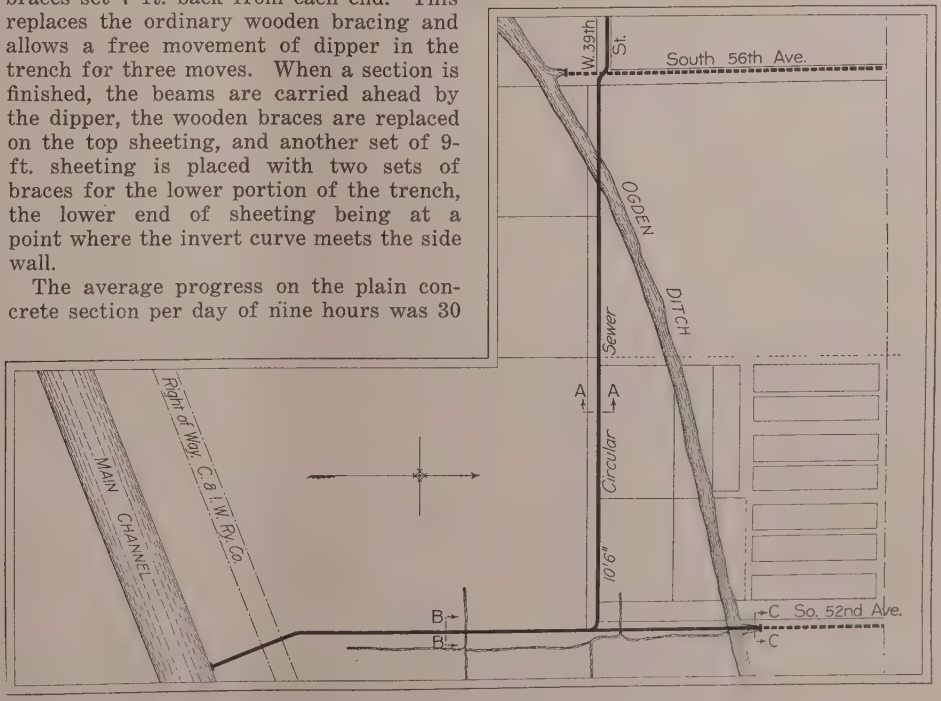
TABLE 1—COSTS FOR PLAIN CONCRETE 12 x 14-FT. SEWER; AVERAGE CUT 23 FT. 6 IN.

Cost per lin. ft.	Item	Cost per cu. yd.
$2.53 Labor .64 Plant $3.17	Excavation	Labor $0.188 Plant .046 $0.234
0.86	Backfill	0.143
0.89	Waste disposal	0.120
0.75	Miscellaneous	.....
1.21	Coal	.....
0.99	Lumber	.....
10.42	Concrete masonry:	
	Labor	1.315
	Cement	1.055
	Sand	0.576
	Gravel	1.103
	Plant	0.804
	Total	$4.133
$13.29	Material and plant 54%	
	Labor 46%	

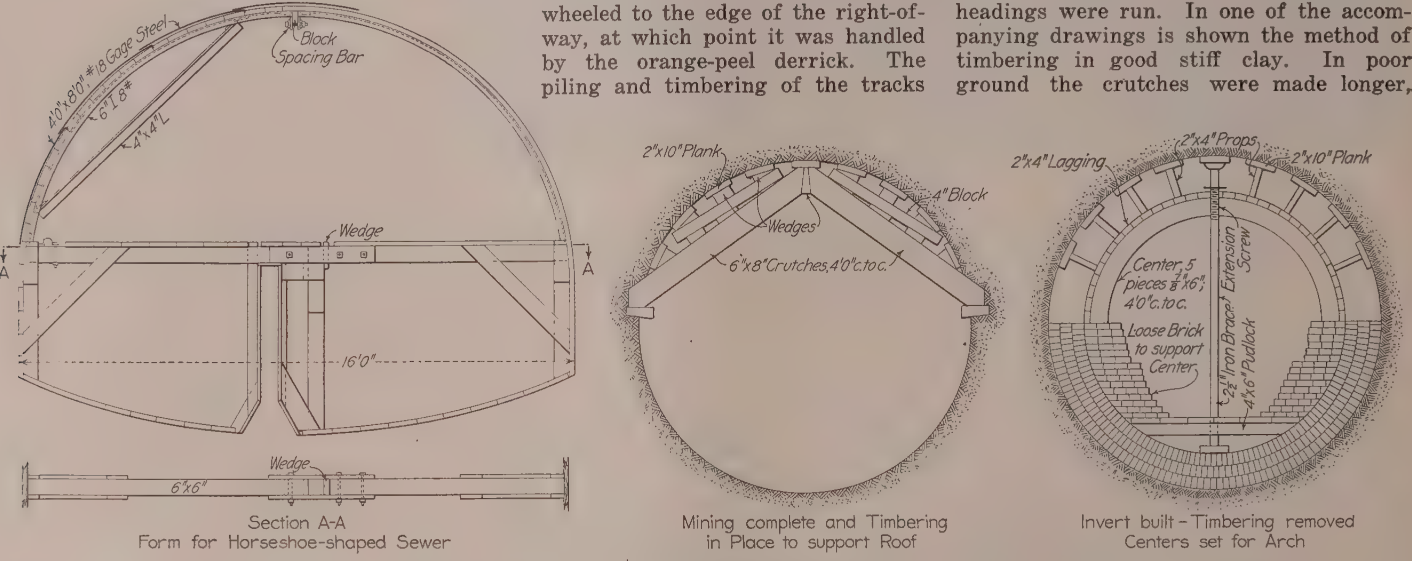
TABLE 2—COSTS FOR REINFORCED-CONCRETE 12 x 14-FT. SEWER; AVERAGE CUT, 22 FT.

Cost per lin. ft.	Item	Cost per cu. yd.
$2.43 Labor .64 Plant $3.07	Excavation	Labor $0.194 Plant .046 $0.240
1.24 Labor Plant	Back fill	Labor 0.249 Plant .021 0.270
0.31	Waste disposal	0.041
2.26	Miscellaneous	.....
1.21	Coal	.....
0.99	Lumber	.....
14.85	Concrete masonry:	
	Labor	1.975
	Cement	1.055
	Sand	0.576
	Gravel	1.103
	Reinforcing steel	1.103
	Plant	0.084
	Total	$5.896
$23.93	Material and plant 52%	
	Labor 48%	

A three-ring brick sewer in South Fifty-second Avenue, Cicero, extends from Ogden ditch to Twenty-second Street, a total length of 10,000 ft., of which 7300 ft. were 7½ ft. and 2700 ft. 7 ft. in diameter. With the exception of 1050 ft. of the 7½-ft. section, which was in tun-



Plan of Sewerage Improvement in the Sanitary District of Chicago nel, the entire conduit was built on the line of an old 4 x 5-ft. wooden box sewer. The sewage flow was usually held back for periods of eight to sixteen hours, depending on rainfall, by a temporary gate, consisting of a 3 x 3 x 12-ft. inclosed box, having a sliding door working vertically about 4 ft. from the upstream end. The old wooden box sewer was first uncovered at a point 600 to 1000 ft. ahead of the steam shovel. After the top was removed, the gate was lowered into the old box and packed in place with sand bags. The gate was operated by a lever at the ground level by a night watchman, who generally closed the gate at 6 a. m. and opened it at 7 or 8 p. m. A 45-ton Bucyrus steam shovel equipped with a 1¼-cu. yd. dipper, excavated the trench, placing the excavated material alongside. The average cut was 21 ft., made in a single cut. The existing box sewer was ripped out by the shovel as the trench advanced.



Section A-A
Form for Horseshoe-shaped Sewer

Mining complete and Timbering in Place to support Roof

Invert built – Timbering removed
Centers set for Arch

Form and Construction Details for Circular and Horseshoe-Shaped Sewers in the Sanitary District of Chicago

During the progress of the work, several severe rainstorms occurred, causing considerable delay and some damage. In a portion of the work where sheeting had been pulled, a severe rain caused the bank to slide, which, together with the added weight of the spoil bank, caused a collapse of 130 lin. ft. of completed sewer. The U. S. Weather Bureau record showed a precipitation of 1.57 in. for two hours. The cost of repairs for this 130 ft. was $11.46 per foot, or 94 per cent of first cost. On account of storms and the softening of the bank by storm and ground water, shorter lengths collapsed. Because of the nearness to building foundations, thereafter sheeting and one set of braces were left in place at an additional cost of 90 cents per linear foot.

Utica cement was used, proving satisfactory in standing up under the night flow of water over new work. A small amount of pointing-up proved necessary in a number of cases where water was passed over the brickwork as soon as laid, and in a special case, when the breaking of the gate had flooded out the bricklayers before the invert could be laid complete. All material was teamed to the work, the average haul being ¾ mile.

The average progress per day on the 7-ft. section was 45 lin. ft., equivalent to 330 cu. yd. of excavation, while on the 7½-ft. section the average progress was 70 ft. per day with 20-ft. cut, or 500 cu. yd. of excavation. The difference in the progress between these two sections was partly due to the fact that the 7½-ft. sewer was built in a street 80 ft. wide, with open prairie on one side and unlimited room for work, and the 7-ft. section was built in a 66-ft. street with scant open space adjacent.

The average number of brick laid per day per bricklayer was 4900 in the 7-ft. section and 5900 in the 7½-ft. section. Backfilling was done with a Monighan revolving derrick, equipped with a Page 1-cu. yd. orange-peel bucket. This is a very efficient machine for backfilling, but the operator should avoid dropping the load from any distance, as it is liable to crack the masonry, especially during wet weather, when the backfill is saturated with water.

At the Illinois Central Railroad tracks excavation was made by hand and the spoil loaded into wheelbarrows and wheeled to the edge of the right-of-way, at which point it was handled by the orange-peel derrick. The piling and timbering of the tracks was done by the railroad company at its own expense. The hand excavation cost $1.25 per cubic yard.

In another case the steam shovel could not take out the bottom on account of the proximity of a viaduct. This earth was scaffolded out at a cost of $1.06 per cubic yard, being handled four times before it reached the spoil bank.

The moving of the steam shovel a distance of 1050 ft. across a railroad yard and over the tunnel section cost $560, or 53 cents per linear foot. This includes the partial dismantling of the shovel to pass under obstructions. At the start the shovel was taken off the railroad spur, moved ½ mile and placed on timbers to span the trench, at a cost of $750.

TABLE 3—COSTS FOR 7-FT. BRICK SEWER; AVERAGE CUT, 21 FT.

Cost per lin. ft.		Item		Cost per cu. yd.
	$2.22 Labor	Excavation	Labor $0.308	
	.28 Plant		Plant .040	
$2.50				$0.348
	0.81 Labor	Back fill...	Labor 0.226	
	.14 Plant		Plant .038	
0.95				0.264
1.00		Waste disposal		0.544
0.19		Pumping		.....
0.62		Miscellaneous		.....
0.35		Coal		.....
1.12		Lumber		.....
7.60		Brick masonry:		
		Labor		2.63
		Teaming		.49
		Brick		4.08
		Cement		.57
		Sand		.29
		Total		$8.06
$14.33		Material and plant	49%	
		Labor	51%	

Unit costs for the 7-ft. and 7½-ft. sections are given in Tables 3 and 4.

TUNNEL SECTION

The tunnel section, 1050 ft. long, extends under the Morton Park yard of the Chicago, Burlington & Quincy Railroad, and passes directly under five piers of the viaduct carrying South Fifty-second Avenue over the railroad yard. In places there was only 12 ft. of covering over the roof of the tunnel. The ground was stiff blue clay, containing but one sand pocket, which caused some earth settlement, visible at the ground surface. There were no settlements whatever at the piers.

The work was carried on by two night shifts of miners and muckers and a day shift of bricklayers, working eight hours each. One shaft was sunk, from which two headings were run. In one of the accompanying drawings is shown the method of timbering in good stiff clay. In poor ground the crutches were made longer, with the lower end set below the spring line, and the 2 x 10-in. planks at the roof were placed closer together. The excavated material was dumped from the shaft into railroad cars and hauled 3 miles to Western Avenue.

The method of setting up the centers for the arch after the invert is built and timbering removed is shown in one of the drawings.

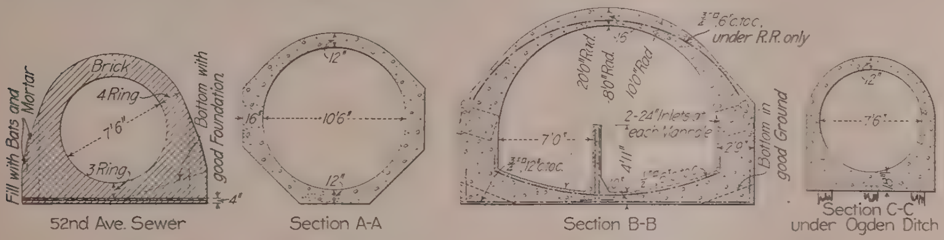
TABLE 4—COSTS FOR 7½-FT. BRICK SEWER; AVERAGE CUT, 20 FT.

Cost per lin. ft.		Item		Cost per cu. yd.
	$1.63 Labor	Excavation	Labor $0.226	
	.28 Plant		Plant .040	
$1.91				$0.266
	0.43 Labor	Back fill...	Labor 0.119	
	.14 Plant		Plant .038	
0.57				0.157
0.41		Waste disposal		0.417
0.15		Pumping		.....
0.81		Miscellaneous		.....
0.35		Coal		.....
0.47		Lumber		.....
7.50		Brick masonry:		
		Labor		2.10
		Teaming		0.30
		Brick		4.08
		Cement		0.57
		Sand		0.29
		Total		$7.34
$12.17		Material and plant	53%	
		Labor	47%	

In each heading the average progress for twenty-four hours was 12½ ft. The average number of brick laid per eight hours per bricklayer was 3000.

Table 5 gives unit costs for the work in the tunnel section.

Work on the South Fifty-second Avenue sewer outlet, in the Sanitary District section, is now under contract. The main section consists of a 12 x 16-ft. horseshoe-shaped sewer, the outfall being at the main channel of the Sanitary District at South Fifty-second Avenue. This section extends north 1800 ft. from the canal to a point where it will divide into two sewers—10 ft. 6 in. and 9 ft. The 10-ft. 6-in. section extends westward to Fifty-sixth Avenue, where it will connect with the 8-ft. 6-in. Oak Park sewer and the Berwyn 5-ft. sewer, both of which now discharge into Ogden ditch. The 9-ft. sewer will extend north across the Ogden ditch and connect with the 7-ft. 6-in. Cicero sewer. This section has a grade of 1 in 5000, the grade being largely fixed by the elevations of the outlets of existing sewers. The dividing wall was designed to keep high velocities in dry weather and avoid deposits. At the upper end of the 16-ft. sewer stop planks are arranged, to divert the dry-weather flow to either side of the dividing wall.



52nd Ave. Sewer
Section A-A
Section B-B
Section C-C under Ogden Ditch

Sections of Brick and Concrete Sewers (See Plan on Page 473)

It was necessary to excavate through the spoil-bank of the Sanitary District main channel before the sewer trench could be started. The equipment comprises a 45-ton Bucyrus shovel with a 1¼-cu. yd. dipper, mounted on 36-ft. timbers to span the trench. The average cut is now 17 ft., with a width of trench of 21 ft. 10 in. Excavated material is loaded into 4-cu. yd. cars and deposited in backfill and the excess hauled about ¼ mile.

The entire work is to be built of 1:2½:5 concrete, except the dividing wall, where it is approximately 1:2:4. The order of pouring is as follows: invert, sides and arch. The invert and dividing wall in the 16-ft. section are reinforced with steel throughout, as is the arch for about 100 ft. where the sewer passes under the C. & I. W. Ry. The reinforcing is designed to take care of any unequal settlement due to soft ground.

Below the spring line the side forms are built of 1 in. flooring, nailed to 6 x 6-in. uprights, 4 ft. on centers, braced by a 6 x 6-in. cross timber at the spring line, supported by a 6 x 6-in. post near the center of the sewer, with diagonals extending to the vertical posts. Above the spring line, 6-in. 8-lb. channels are used, curved to the proper radius, and reinforced with a 4 x 4-in. angle, 8 ft. long at the quarters. On the ribs, which are spaced 4 ft. on centers, is placed 2 x 6-in. lagging, on which sheets of No. 18-gage sheet steel is laid, lapping about 6 in. For the dividing wall the form is built up of wooden sheets 8 ft. long, suitably braced against the side walls, with steel separators between to maintain the proper spacing.

TABLE 5—COSTS FOR 7½-FT. BRICK SEWER, IN TUNNEL

Cost per lin. ft.	Item		Cost per cu. yd.
$6.49	Excavation		$2.43
2.05	Waste disposal		0.77
.40	Lumber		.....
.15	Power		.....
1.26	Miscellaneous		.....
9.35	Brick masonry:		
	Labor		4.40
	Brick		4.09
	Cement		0.57
	Sand		0.29
			$9.35
$19.70	Material and plant	27%	
	Labor	73%	

Contract prices per linear foot for the work are about as follows: 16-ft. sections in 17-ft. cut, $40.63; 10½-ft. section in 12-ft. cut, $15.48; 9-ft. section in 14-ft. cut, $12.83.

COST KEEPING METHODS

For the use of the sanitary division of the district, a daily report was devised, for labor and progress of the work, designed to fit either a brick or concrete job. The distribution of hours is made at the time the form is filled in. The rate per hour need not be filled in daily, since this can be covered on one sheet showing the rates for the entire job. From these reports a monthly tabulation is made, the rate per hour applied, and extensions made reducing the whole to a money basis. At the end of the job, the monthly statements are compiled, making one tabulation for the entire job. The weekly reports for material can be handled in the same way.

A daily report for material was also devised, showing the amount of cement in the warehouse, the amount used in the work, and the yardage of concrete placed. The tally on cement is kept by the inspector at the mixer as the bags are delivered. The inspector can also fill in the station numbers showing progress. The number of cubic yards placed can be entered by the engineer in charge. A small table showing the number of cubic yards per running foot of invert, sides and arch, is a very handy thing so that quantities can be entered without any extended computation.

The item of plant charge is a difficult one. For instance, there are steam shovels in service to-day that are twenty-five years old, whereas others are worth only scrap value at the end of three or four years. Many contractors charge off the entire plant to the job. So far as I see, for machinery such as steam shovels and dinkeys, it is fair to spread the plant cost over a period of ten years, allowing interest at 6 per cent on first cost, thus making a depreciation charge of 16 per cent per year. Alterations, fitting up, freight, small tools, etc., are directly chargeable against the job, and should be added.

In considering the overhead charge to be made, some figure must be taken in making up an estimate. This is more apt to be too small than too large. In Illinois liability insurance will cost from 7½ to 11 per cent of the payroll, and on work described in this paper the labor item is about 50 per cent of the total field cost for open cut work, and 70 per cent for tunnel work. This makes a charge of 3½ to 8 per cent for insurance. Office rent, telephone, cost of getting work, and other items may increase this to 10 or 15 per cent. Adding 15 per cent for profit, we thus have 25 to 30 per cent to add to the field cost. With the aid of the data contained in the tables, reinforced by current market quotations on material, the author has made estimates for similar kinds of sewer work, in the aggregate about one-half million dollars. Such estimates agree with the low bid within 4½ to 7 per cent. In transferring the unit costs for work already performed to new estimates, due consideration must be made for differences in the local conditions, character of the soil, any increase in cost of labor, and the availability of standard types of machine to handle the work.

The contractors on the jobs described in this article follow: West Thirty-ninth Street conduit, John W. Farley & Company; Fifty-second Avenue job, Cicero, James Healy; Fifty-second Avenue job now under construction for the Sanitary District, H. J. McNichols Company

Construction was carried on and the data in this article were compiled by the writer as resident engineer for the Sanitary District, under the direction of Langdon Pearse, division engineer, and George M. Wisner, chief engineer. S. A. Greeley, assistant engineer, has been in charge of the design on South Fifty-second Avenue.

Preparing Turbidity Standards

CORRECTING silica turbidity standards prepared by weight by the use of a field method, as outlined in the standard methods of the American Public Health Association, is criticized, as being impossible of duplication, by Francis D. West, chemist, Bureau of Water, Philadelphia, in a paper presented at the recent meeting of the Illinois Water Supply Association. He suggests, as an alternative, a method found satisfactory since its adoption in the Philadelphia laboratories in 1901. This method involves the preparation of diatomaceous earth. The Philadelphia method is to take a weighed amount of finely ground material, about 2 grams, and suspend it in 500 cu. cm. of distilled water, shaking vigorously for two or three hours. After suspending for ten hours the supernatant liquid is decanted and the residue dried and weighed. The difference equals the amount in suspension. This is diluted to standard and used as stock. Mr. West states that standards so made from different stocks do not differ perceptibly, as all material that remains suspended for ten hours appears to be of the same degree of fineness. Standards made in 1907 containing a small amount of mercuric chloride have not been found to change, but checks should be made every six months.

To do away with the tedious grinding of the diatomaceous earth, the experience of preparing stock solutions with fuller's earth, first brought out by Dr. E. C. Levy, was also given by Mr. West. Five grams of sifted material, or 20 grams of unsifted fuller's earth, are agitated as above in a gallon bottle with one quart of distilled water. After ten hours the material in the suspended matter is determined by precipitation with a known amount of aluminum hydrate. Working then with a definite weight and definite degree of fineness, standards have been made of the fuller's earth which check exactly with the diatomaceous earth.

Public Rights over Navigable Streams

Recent Decisions of the U. S. Supreme Court Imposing Limitations Upon the Rights of Private Owners of Land

By WILLIAM B. KING
Of the Bar of the Court of Claims, Washington, D. C.

A NUMBER of cases bearing upon the rights of the United States to improve navigation and the rights of owners of either adjoining or near lands to compensation for damages charged to have been suffered by them have recently been decided by the U. S. Supreme Court. The cases arose in Michigan, New York and Mississippi and involve a wide application of the law on this subject. Their interest to engineers lies in the fact that engineering construction in navigable waters frequently involves just such questions of private right.

The Michigan case was in connection with the St. Marys Falls Ship Canal at Sault Ste. Marie. On March 3, 1909, Congress declared that absolute ownership by the United States of all lands between the canal and the international line was necessary for the purpose of navigation. Authority was given to the Secretary of War to acquire all such lands and property of every kind and description, and jurisdiction was given to the United States Court to condemn the lands and decree payment of the money. In the course of the condemnation, claims were made by various light and power companies for compensation, not only for the land owned by them adjoining the river, but for the value of the water power used by them. The cases of the Chandler-Dunbar Company and the St. Marys Falls Power Company were taken to the U. S. Supreme Court for a determination.

It appears that all these companies occupied and used the water under a license from the Secretary of War, revocable at his discretion, and revoked in fact under the authority of the act of 1909. The Supreme Court decided that these companies had no right against the United States to compensation for the value of the water power used by them, basing this upon the ground that the ultimate right to water in a navigable stream belongs to the United States and that the right to improve the stream for purposes of navigation is superior to any private right of the owners of adjoining land to the water in the stream.

This decision, known as United States versus Chandler-Dunbar Company, is published in Vol. 229 of the U. S. Reports, page 53. It both emphasizes and expands the decisions in earlier cases; it asserts very strongly the rights of the public; it is in line with the general current of political criticism of the day, which insists upon the conservation, as far as possible, of the resources of the public and opposes the grant of private rights in public property.

[The decision was abstracted in the Engineering Record of June 21, 1913, page 699, and commented upon editorially on page 678 of the same issue.]

NEW YORK CASE

The New York opinion immediately follows that already discussed and is in the case of the Lewis Blue Point Oyster Cultivation Company versus Briggs. The defendant was a contractor with the United States for dredging upon certain lands under the waters of Great South Bay in New York. Congress had authorized a channel 2000 ft. long and 200 ft. wide across this bay. The plaintiff was the owner of certain submerged land in the bay which it was using for the cultivation of bluepoint oysters. The plaintiff alleged that the dredging of this channel would destroy the oysters of the plaintiff, not only along the excavation but for some distance on either side. The Supreme Court was not negligent of the importance of the oyster industry, but held that the public right to improve navigation was dominant to any private interest in navigable waters.

The decision of the court below refusing an injunction to restrain the contractor from proceeding with its work was upheld, the ultimate ground being stated as follows:

"By necessary implication from the dominant right of navigation, title to such submerged lands is acquired and held subject to the power of Congress to deepen the water over such lands or to use them for any structure which the interest of navigation, in its judgment, may require. The plaintiff in error has, therefore, no such private property right which, when taken, or incidentally destroyed by the dredging of a deep water channel across it, entitles him to demand compensation as a condition."

Precedents were cited sustaining this decision and reference was made particularly to the Michigan cases as based upon practically the same principle.

MISSISSIPPI CASES

The Mississippi cases go perhaps farther even than the cases already considered in assertion of public and denial of private rights. They are the cases of Jackson versus United States, and Hughes versus United States, on appeal from the Court of Claims, and appear in Vol. 230 of the U. S. Reports, pages 1-24.

These cases arose under the laws authorizing the improvement of the Mississippi River and the acts done by the Mississippi River Commission in connection with this improvement. The Government had erected in combination with State and municipal authorities and with private owners a continuous levee system on the west bank of the Mississippi River, closing large basins into which the river theretofore had overflowed. Similar levees had been erected along portions of the east bank. It was the belief of the advocates of this plan that confining the flow of the Mississippi River would cause a scour between the levees and consequently would keep the channel at a reasonably stationary depth. Between Vicksburg and Baton Rouge, La., on the west bank of the river, the hills or uplands constituted the ultimate bank of the river, receding for a certain distance and then again abutting on the river. Between the river and the varying line of hill or upland is an area of alluvial country.

The land of the plaintiffs was situated in one of these semicircles, bounded on the west by the river and on the east by the base of the uplands or hills. Prior to the improvement of the Mississippi River under the plans of the commission these lands were protected by moderate private levees. Occasionally they were overflowed, but this did little damage. Since the building of the levee along the west side, the Jackson lands are subject to much greater overflows, so that they cannot be cultivated, and the scour has thrown great quantities of sand upon them. They are rendered practically valueless and the claimant in the Court of Claims asserted that they had been taken by the United States for public use and that he was therefore entitled to just compensation for them under the provision of the fifth amendment to the constitution. The claimant laid stress upon the fact that the Mississippi River Commission had adopted the line of hills bounding his plantation upon the east as a portion of the river improvement system, which in effect put him in the bed of the river in flood times.

GOVERNMENT'S INTERESTS PARAMOUNT

The Supreme Court, in an elaborate and positively expressed opinion by the chief justice, declared that the right of the United States to improve the navigation of the river was paramount to that of private owners along the line of the river and that they must suffer such damage as might come as the result of the Governmental policy, without being entitled to any compensation therefor. The opinion supposes that the improvements in question had been made by private individuals and asks whether it is possible that these individuals could have been restrained from protecting their own lands on the ground that their levees would injure the land of others. It ends by a citation of the principles laid down in the Michigan cases.

A further opinion in the second case, that of Hughes versus United States, carries this principle still farther. Hughes was the owner of lands similarly situated to that already described. He had built a levee protecting his lands from the Mississippi River, but the Government built a levee behind his land, connecting this with already existing levees, so that his land was directly placed by the Government levee in the bed of the river, although he had been in the past shut off from the bed of the river by his private levee.

The Court of Claims had held that this condition entitled him to compensation, but the Supreme Court reversed the decision.

It will be seen that these opinions are far-reaching in their effect upon owners of land along navigable streams, and apparently hold that these owners have no rights unless the Government actually takes possession of the lands.

PREVIOUS DECISIONS

It is difficult to see how the last opinions can be reconciled with some previous decisions of the Supreme Court, but doubtless when occasion arises the court will point out the discriminations between the two cases. The previous case coming nearest to these cases in which the decision was in favor of the private owner was that of United States versus Lynah, reported in Vol. 188 of the U. S. Reports, page 445. Here Congress appropriated money for the improvement of the Savannah River. The plaintiffs were the owners of real estate bordering on the river. Government engineers placed dams, training walls and other obstructions in the river so as to hinder its actual flow and to overflow the land of the plaintiffs, thus causing total destruction in value. It was held that this was the taking of the land for public purposes and the Government was obliged by judgments of the courts to pay for the value of the land.

Although this case was urged upon the consideration of the Supreme Court in the decision just cited, it is not referred to in the opinion, so that the public is without information as to the line of discrimination which the Supreme Court considers should be made between the two cases.

The effect of these decisions on public engineering projects will be to relieve them from contingent liabilities for the invasion of private right. This will to that extent encourage work by the United States, the States and municipal corporations. Their effect upon development of private enterprise will be equally discouraging, not only for the doctrines of law directly laid down, but for the tendency shown in them to disregard acquired private rights when in conflict with public claims.

Operation of Imhoff Tanks

Prof. Charles Gilman Hyde Suggests Routine Duties in Sewage-Plant Maintenance

BASED on general and local experience in California a tentative program of operations of Imhoff tanks, given below, is suggested as essential to satisfactory and effective results by Prof. Charles Gilman Hyde in a recent issue of "Pacific Municipalities."

Cleaning Basin Walls.—Every few days the walls and sloping bottoms of sedimentation chambers should be scraped with a rubber squeegee, a flat hardwood board from 12 to 24 in. long and from 3 to 4 in. wide with rubber edges and a light wooden handle of length determined by the dimensions of the chambers. All adhering solid matters should be pushed down through the slots. Floating materials, such as matches and corks, behind baffles and all scum collecting upon the surface of the sewage passing through the chambers should be removed by a dish-shaped perforated skimmer, 18 to 20 in. in diameter, attached to a long wooden handle. This scum and floating material may be thrown into the scum chambers connecting with the digestion chambers. No decomposing material should be allowed to accumulate in these chambers; otherwise, septic action may take place and disagreeable odors be produced.

Reversal of Flow.—In installations where two or more tanks are operated in tandem the flow should be reversed in direction through the tanks at least once a month.

Breaking Up Scum.—Every few days, depending upon the character and composition of the scum and the rapidity with which it is formed, the scum collecting in the scum chambers should be thoroughly broken up with a rake and pushed down into the digestion chambers. If this is not faithfully and consistently done at sufficiently frequent intervals the depth of scum may become excessive. It will not digest properly and may give off more or less offensive odors of decomposition. If, in spite of frequent and thorough agitation, the scum layers continue to deepen, relief may be had by spraying them with a hose under pressure, thus breaking up the particles somewhat and liberating the entrained gas. If this is ineffectual and the scum layers become too deep, dense and hard, they should be removed by shovels. The scum so removed during the ripening period should preferably be placed in a pit and covered with earth. After the process of digestion has become effectively established in the lower chambers, any scum removed from the scum chambers may, in some cases, be satisfactorily treated by placing upon the sludge-drying bed and mixing with the digested sludge.

Sludge

Observing Sludge Increase.—The rate of deposition of the sludge should be carefully watched, the elevation of its service being determined as frequently as once in each week or ten days. This may be done by means of a weighted board or sheet iron plate from 12 to 18 in. square attached to a wire or cord, or to a long light rod of wood or gas pipe.

Sludge Removal.—When the surface of the sludge has risen to a point 18 or 20 in. below the slots some of the thoroughly digested sludge at the very bottom of the tank should be drawn off. The amount withdrawn at any one time should not be too great. In the first place only well-digested sludge should be removed. It is better, at least in large plants, to remove relatively small amounts of sludge at frequent intervals than to withdraw very large amounts infrequently. If the entire volume of sludge were removed at any one time the entire process of ripening and establishing effective biological action in the lower chamber would require repetition. This ripening period is sometimes marked by very excessive and troublesome scum formation. Great care must be taken not to allow the sludge to pass too rapidly out through the sludge withdrawal pipes because the less well digested and softer sludge nearer the surface might be forced by the water pressure out of the tank rather than the more compact, thoroughly digested and less-readily flowing sludge at the bottom. In other words, an inverted cone of least resistance might be formed and eventually only liquid, rather than solids, would pass from the tank.

Perforated Pressure Pipes.—If the sludge should not flow readily through any sludge removal pipe it may be loosened by forcing clarified sewage or water through the perforated pressure pipe in the bottom of the digestion chamber. According to Saville, excessive scum formation may sometimes be checked by the occasional use of this perforated pipe. When this is done some of the gas in the sludge is driven off and there is consequently less tendency for it to rise into the scum chambers. Furthermore, if the activity of the organisms in the sludge seems to be retarded, due to the excessive formation of so-called enzymes or other by-products of their existence, these may be disseminated and diluted by spraying fresh clarified sewage or water through the perforated pipes in question.

Refilling Sludge Pipes.—After each withdrawal of sludge the sludge pipe should be backfilled with water or clarified sewage, otherwise it would almost certainly become clogged with dried-out sludge. Should the sludge pipe become clogged it may be cleaned by pushing a rod through it or by forcing water or clarified sewage through it under sufficient pressure. In order that these methods of cleaning may be utilized the straight run of the pipe should be continued to a point slightly above the high water line in the tank. This portion of the pipe may be capped if desired, the cap being fitted with a pump connection.

Drying Sludge.—The depth of sludge deposited upon the drying bed at any one time should not be over 12 or 15 in. In dry weather the sludge should become spadeable in a few days and should be removed from the bed. Whenever the surface layer of the sludge-drying bed becomes clogged, or is taken away in the removal of the sludge, a new layer should be applied. This feature is important in order that water draining from the sludge may be removed quickly either by seepage into the underdrainage system or into the naturally porous subsurface materials.

Sampling and Testing of Sewage.—The operator in charge of the works should be provided with Imhoff conical glass graduates for testing the amount of suspended matter in the raw and settled sewage. Ordinarily, this testing should be done once a day, but occasionally it should be done throughout the day in order to determine the variations in the composition of the sewage. Every installation should be provided with a measuring weir, suitable orifices or other devices for determining with reasonable accuracy the rate of flow of sewage. Whenever possible a recording, self-integrating gage should be installed to exhibit the flow of sewage at all times.

Erecting 150-Foot Stack with 10-Foot Ginpole

Novel, Cheap and Expeditious Method Employed at a Sugar Plant Near San Domingo, West Indies

A STEEL smokestack 9 ft. in diameter and 150 ft. high was recently erected in an unusually simple and expeditious manner by R. Dunseath, of New York City, for the Hugh Kelly Sugar Company, at its plant about 30 miles from San Domingo, West Indies. A scaffold consisting of four 3 x 3-in. braced vertical posts in 5-ft. lengths was built up inside the stack as each successive 5-ft. course of the steel shell was erected. The vertical posts were connected by horizontal 6 x 1-in. boards nailed on and were wedged against the shell but not X-braced. At the top of each story a working platform of loose boards was laid and a 6 x 8-in. horizontal piece wedged and bolted securely in position to receive the foot of the gin pole. The gin pole was an 8 x 8-in. timber 10 ft. long fitted with a spider and guy lines and tackle connection at the top, and with a $1\frac{1}{2}$-in. gudgeon pin at the bottom that engaged a hole in the foot block. It was so light that it was easily lifted by hand as the work advanced and the scaffold was built up to correspond.

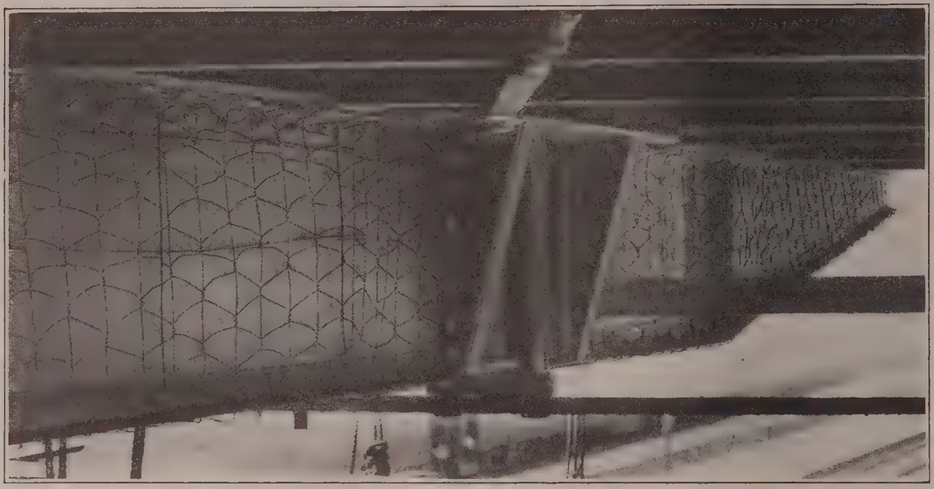
All rivets were driven by hand, by four men. The cost per rivet was 4 cents. When not engaged in riveting the men performed the work of assembling and scaffold building at a price of 75 cents each per day of $10\frac{1}{2}$ hours. Four more men were employed on the ground at a price of 65 cents per day and the work was accomplished by this force in twenty-two days, although the estimated time required for the job was between three and four months.

A TUNNEL UNDER the Danube is planned by the Roumanian Government to form a connection with its newly acquired territory. A bridge was first considered, but as no protected site was to be found, military precautions forced the abandonment of the project. The proposed tunnel will have heavily fortified terminals.

Concrete Protection for Street Bridge

Incasing Floorbeams of Old Wrought-Iron Span to Shield Them from Locomotive Gases when Paint and Wooden Ceiling Were Inefficient

SMOKE and gases from 500 locomotives per day passing under the 146-ft. span of the Calvert Street highway bridge, Baltimore, corroded the lower members of the superstructure so badly that it has been found necessary to protect them by a concrete casing, applied with the cement gun. The bridge, 62 ft. wide and about 600 ft. long, was erected in 1878 at an approximate cost of $220,000. The 146-ft. span over the tracks of the Pennsylvania Railroad is built of wrought-iron with three through bowstring trusses. The plate-girder floorbeams, over 75 ft. long and 3 ft. deep, have cantilever brackets projecting nearly 13 ft. beyond the track centers and are suspended by three pairs of eyebars engaging pins through the vertical posts of the trusses. They carry I-beam joists and a paved buckle-plate floor and are about 26 ft. in the clear above the base of rail.



Floorbeams Inclosed by Steel Fabric to Anchor Concrete Protection

Locomotive gases caused such damage that none of the various brands of paints which were successively applied endured for more than one season. A year ago a portion of the structure was painted and protected until the paint was thoroughly hardened by a section of wooden floor suspended from the bridge by cables with a 5-ft. space between it and the bridge. The bridge members were then thoroughly cleaned by hand and painted with two coats of paint. The wooden flooring was left in place for about one week, to enable the paint to thoroughly harden before exposure to the blasts of the locomotives and the gases arising from the stacks. This protection did not appear to give good results and it was considered not to pay for the expense involved. More efficient protection was, therefore, necessary and after considerable study it was finally decided to use concrete for this purpose, and two plans were submitted.

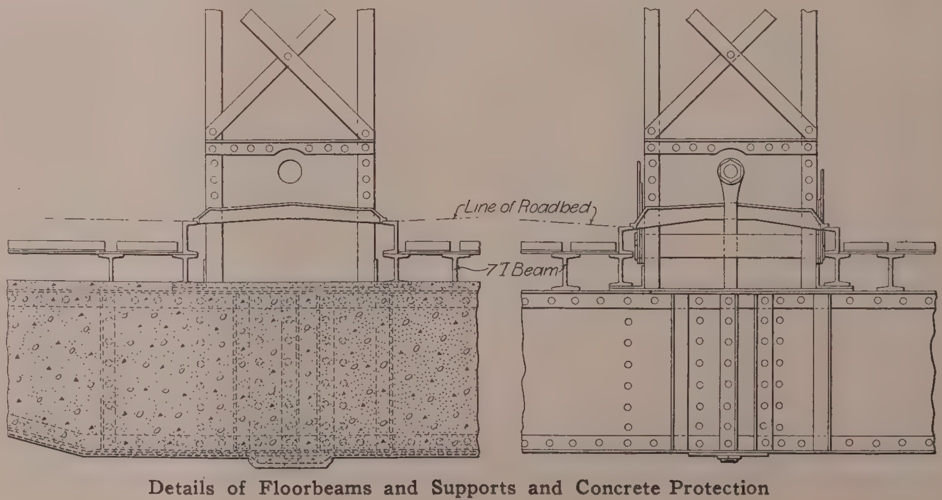
CONCRETE PROTECTION

One method proposed for protecting the steelwork involved the construction of thin horizontal concrete slabs resting on the bottom flanges of the floorbeams and covering all the spaces between them, the inclosing of the bottom flanges of the floorbeams, and the construction of vertical concrete walls reaching from the bridge floor to the horizontal slabs on the ends and sides of the span, thus forming closed chambers of the depth of the floorbeams over the whole floor area of the span. This system required about 7000 sq. ft. of vertical and horizontal sheathing for the portion under the main roadway, or 9300 sq. ft. if extended to include the sidewalk crossing.

The alternative plan was for inclosing the entire surface of the floorbeams with about 4000 sq. ft. of reinforced concrete $1\frac{1}{2}$ in. thick. This method was adopted and the work executed by the D. M. Andrew Company, of Baltimore, for a contract price of $1.25 per square foot.

Holes were drilled through the floorbeam webs for the attachment of reinforcement rods and small transverse horizontal channels were bolted 2 ft. apart to the bottom flanges of the roadway joists. The cement grout was then placed on the exposed surfaces by the pneumatic process operated by the New York Cement Gun Company. Before concreting was commenced all of the exposed steelwork was thoroughly cleaned and the old paint removed by chemicals and by the sandblast. The contract includes the maintenance of the concrete covering for two years. One gang consisting of four men was kept busy constantly in moving and erecting the scaffold for the sandblast men. The same scaffolds were utilized by the men placing the reinforcement steel and drilling the holes to receive its connections.

The work was done under the direction of H. K. McCay, city engineer.



Details of Floorbeams and Supports and Concrete Protection

Erecting a 100-Foot Standpipe by Hand

Utilizing the Strong Arms of Bystanders in Lieu of Steam or Electric Power

NEITHER steam nor electric power was utilized in the erection some time ago of a 20-ft. standpipe 100 ft. high for New York City at Silver Lake, Staten Island. The bottom of the standpipe consists of two $\frac{1}{2}$-in. plates united by a diametrical-strap spliced joint. In order to give clearance for the pipe connections through the plates and to insure that the plates were properly bedded on the cement motor covering the foundation pier, they were temporarily supported on a number of vertical wooden struts seated on the pier. Each strut was made of a pair of 12-in. planks 30-in. long nailed together at right angles to form L-shaped columns.

As no derrick was conveniently available for handling these heavy bottom plates, a large number of loungers were induced, by the payment of $5 to treat the crowd, to lift the plates bodily and hold them up until the temporary supports were placed under them.

Provision for lowering the plates to their mortar bed was made by nine $1\frac{7}{8}$-in. holes through each half of the bottom. These holes were tapped for standard bolts and the latter, provided with full-length screws, were engaged in them and acted as jackscrews by which the plate was gradually lowered to position after the wooden supports had been removed. Subsequently the jackscrews were detached and the holes at the sides were permanently filled with screwed plugs calked in position.

The 5-ft. courses of the standpipe shell were erected by a gin pole made of 20-ft. lengths of 12 x 12 and 10 x 10-in. timber. A 10 x 10-in. timber fitted at the upper end with connections for guys and tackles was seated on the base plate at the center and guyed to adjacent trees. After the lower courses of the shell had been erected, the guys were loosened and the ginpole was hoisted up high enough to permit the insertion underneath of a second 20-ft. length of 10 x 10-in. timber, which was securely spliced by four 3 x 15-in. wooden scabs 12 ft. long, securely bolted. These scabs being wider than the timber, each projected on one side, giving the splice additional stiffness. The ginpole was equipped with a hand crab and the work was executed in six weeks by a force of ten men under the direction of R. Dunseath, of New York City.

Value of a Library in an Engineering Office

Arguments in Favor of Converting the Dusty Pile of Pamphlets and Periodicals into a Central Bureau of Useful Information

By LOUISE B. KRAUSE
Librarian, H. M. Byllesby & Co., Chicago

WHY should an engineering firm build up an office library? The answer to this question is almost unanimously agreed upon by professional men of highest standing, and the reasons why may be briefly stated as follows:

First. The success of engineering work depends on accurate information, for information is as necessary a tool in the examination, design and construction of engineering enterprises as the mallet and chisel are in the work of an artisan. A knowledge of the experience of others, gained through the medium of print, is invaluable in producing the best results to be achieved in any line of work.

Second. The competitive element in modern business requires that everyone should know, if possible, what everyone else is doing, and the best way to find out is by means of printed information.

A prominent engineer, head of an industrial laboratory, recently stated in an address that industrial laboratories "should each one be developed around a special library, the business of which should be to collect, compile and classify in a way to make instantly available every scrap of information bearing upon the materials, methods, products and requirements of the industry concerned"; while a noted water-supply engineer, writing upon the work of a consulting engineer in a recent periodical, states that the consulting engineer "should have a specialized library of all waterworks literature, carefully filed and indexed for ready reference, and that if he be wise he should expend a good deal of time and money in tabulating data, forming a data file for ready reference on all of the more independent subjects that are likely to come before him."

Methods of Building Up an Office Library

Taking it for granted, therefore, that engineers in general are convinced of the value of collecting printed information bearing upon their particular lines of work, the more serious and vital question is, How can this information be most economically collected and efficiently administered? Or, in other words, What are the best methods of building up an office library?

The first step in the building up of an office library is the concentration or collection of all the printed material available in the office in one place. This is exactly what is not done in a large number of offices. Books, pamphlets and other information are scattered among the various members of the organization, who treat them as personal property and preserve them in their private desks as carefully as a squirrel hides his store of good nuts. The policy in many offices in regard to information seems to be to hang on to everything of value for one's personal use, regardless of how much value the information might be to another member of the organization and also regardless of the fact that the material has been paid for out of company funds. The ethics of such procedure is exceedingly questionable, for it certainly is self-evident that both material and time which are paid for by an organization should be used for the best interests of the organization as a whole.

Too much emphasis cannot be placed upon this first principle of the successful office library, namely, that all material should be shelved in one place, making it of equal access to all members of the organization.

Technical Periodicals and Indexes

The next important step is the proper preservation of technical periodicals. The failure to preserve, by binding, files of valuable periodicals is another sin of omission to be laid at the door of many offices. Single numbers are lost through the carelessness of the office force or are rendered useless by items having been cut out according to the interests of the various readers. It is certainly legitimate for a man to clip or lose the copies of a periodical for which he personally subscribes, but it is certainly not legitimate for him to mutilate a file which should be preserved for the benefit of the whole office.

The question has arisen whether it is not more advisable to cut up periodicals and preserve only articles of special interest than it is to bind the volumes, which take up more shelf room. While it may be advisable to clip certain articles of interest from miscellaneous journals whose general run of material is only of occasional interest or value, on the whole the practice of clipping and filing only portions of the best technical journals is a short-sighted policy and not an economical or efficient one for an engineering office. No engineering office is prophetic enough to foresee exactly what information needs to be cut out and preserved for future use when one considers the variety of valuable material found each week in the leading technical journals.

Something may be said in favor of articles being clipped for a personal file by individual engineers who subscribe only for two or three journals and whose range of interests is bound to be more limited than those of a whole office staff. One of the best filtration engineers in this country has for years cut up the Engineering Record and mounted certain articles on stiff manila sheets and filed them by subjects in pamphlet boxes. But even in such an individual case is there not danger of a need for information arising which an engineer has not foreseen and in which a bound file of a periodical would prove invaluable? There must be taken into consideration also the time consumed in selecting, clipping and filing, which would be eliminated if the volumes were bound. If aid is needed for quick location in the bound volumes of special articles of interest, a brief subject-card index can be easily prepared.

In addition to binding up sets of periodicals for the office library there should be purchased the general indexes to technical periodicals, as the "Engineering Index Annual" and the "Industrial Arts Index," and any cumulated indexes to the individual journals of which the office has a file. These general indexes will, of course, give references to many periodicals not in the office library, but they render the valuable service of directing attention to information not at hand but which can be easily procured from the large public or engineering libraries of various cities.

What to Do with Pamphlets

Every engineering office receives a quantity of pamphlet material which is either not preserved or which soon grows into a dusty pile of unsorted material. There are only two ways of disposing of a pamphlet—either put it into the waste-paper basket or treat it as worthily as a book, for the value of any pamphlet is not to be determined by its size or binding but by the quality of the information which it presents. The chief objection to a pamphlet, no matter how valuable its information, is its lack of durability; the leaves are generally poorly fastened together and it soon becomes dog-eared and torn. Two methods of preservation may be used—either put each individual pamphlet into a binder, such as the Gaylord pamphlet binder, or use pamphlet boxes in which to group pamphlets on certain subjects and stand them on the shelves with the books treating of the same subjects. Individual pamphlet binders are, in the opinion of the writer, to be preferred, as they give a pamphlet a stiff cover, which makes it more neat and durable. The general rule governing the care of pamphlets should be that a pamphlet worth keeping should be treated just as a book is treated.

The vertical file has been used for taking care of pamphlets, but it seems to the writer more advisable to bring all material on a subject together on the shelves than to have it filed in two places. The vertical file is the best method of filing manuscript and typewritten data which supplement the material found on the library shelves but which cannot be conveniently put upon the shelves because of their form.

Other Material to be Included in the Library

The library in an engineering office should never be limited to collecting books and pamphlets only, but should be built up in accordance with the broadest idea contained in the word library, namely, information of all kinds in any form which may be useful in the work of a particular organization. This means not only books, periodicals and pamphlets, but also photographs, trade catalogs, manuscript data of general interest, specifications, and valuable notes accumulated in connection with the specific work of the organization. It is a lamentable fact that the work of many offices is handicapped by want of co-operation among its members, shown in a selfish withholding of information by which "the other fellow" could profit and to which he is lawfully entitled. There is also a tremendous waste of both time and experience, which means money, due to the failure to put on file for future reference all data which have been accumulated in years of study and work by the employees of an organization. In some cases where an effort has been made to file such data their future usefulness has been reduced to a minimum by want of an adequate system of filing under competent supervision.

It is a self-evident fact that only continuous and competent supervision can assemble and make valuable such a variety of information. It cannot be done by the average office helper, either office boy or stenographer, and it is not economy to use the services of one of the engineers, whose time is more valuable along the line of his special knowledge, and who, also, has no familiarity with methods of library work. The failure of many engineering offices to realize the value of building up a library is due to the fact that the work is put into the hands of someone in the organization who does not know how to collect information or how to make it quickly available after it is obtained. The office stenographer who is busy with other work has not the time, nor does he know how to do it even if he had the time; while the engineer who is competent to pass upon the merits of the desired information after it is obtained does not know in many cases just where to get the information from outside sources. The writer knows of concrete instances in which engineers whose time is worth a large sum per day have spent a number of hours in locating technical information which could have been found in a much shorter time by a trained librarian, the cost of whose services by the month would have been equal only to the market value of the expert engineer's services by the day.

It might be well to state in connection with expense that an engineering-office library can be built up at a comparatively small cost, because a large proportion of its most valuable material can be obtained free of charge from the U. S. Government and also from State and private sources.

"The Librarian Knows How"

The argument for the employment of a trained librarian can be briefly stated in four words—the librarian knows how. The librarian knows how to procure valuable information contained in Federal and State reports, knows how to keep up with the literature of the engineering profession and how to obtain desirable printed data which cannot be purchased and which must be obtained from private sources. The librarian knows how to use all kinds of indexes, how to use quickly the facilities of large city libraries, how to catalog and index according to standard practice, so that no time or money is wasted in experimenting with original systems; and last but not least, always has a place for everything and everything in its place. The librarian also makes a business of knowing about all the work of the office and co-operates with each department which needs information or help, and is able therefore to put one department in touch with what another department is doing. The librarian also keeps up with the field of print, which the engineer is too busy to look over for himself, posts him on what he ought to know, and, in brief, becomes to the office a walking guidepost and a living index.

Should the question arise as to whether there is work enough in any one office to keep a librarian busy (a condition which the writer seriously doubts), it might be well to state that the educational qualifications of librarians make it possible to use them on a variety of work.

In conclusion, it may be stated that it seems a short-sighted policy for a large engineering office to fail to add to its staff a librarian who can make readily accessible information of inestimable value in the successful prosecution of its work.

THE ELECTROCUTION OF TEREDOS, by turning an electric current into the piles, is being tried at Seattle, according to a recent consular report.

Constructing Deep New Foundations in Old Building

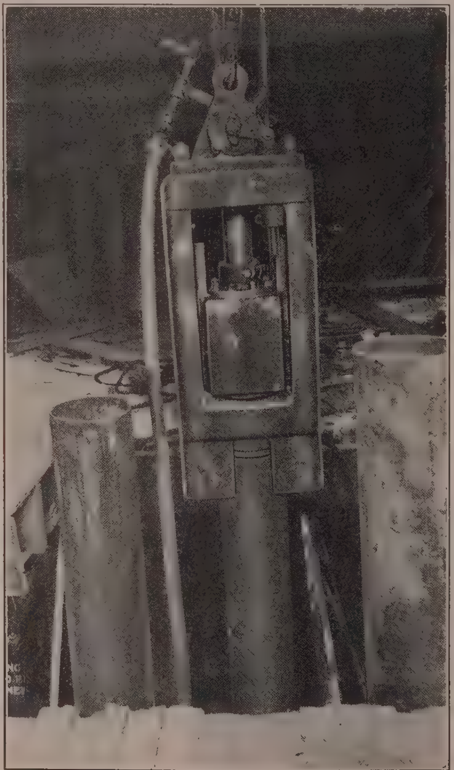
Steel Piles, 25 Feet Long for New Skyscraper, Driven to Rock in 8-Foot Cellar Before Old Building Was Wrecked

SAVING of time has been effected in the construction of the twenty-story office building on Twenty-Seventh Street, between Broadway and Fifth Avenue, New York, by the use of methods which have enabled the contractor to carry a large proportion of the new foundations to deep rock before the removal of the old seven-story Victoria Hotel which previously occupied the L-shape lot with fronts of about 106 ft., 254 ft., and 63 ft. on Broadway, Twenty-Seventh Street and Fifth Avenue, respectively. While the hotel was still filled with guests the contractor commenced to install his plant, began active foundation operations in the cellar, and continued them during the progress of the wrecking of the superstructure, thus saving several weeks of valuable time and accomplishing a large portion of the foundation work before the site was cleared.

The contract for the construction of sixty-three piers with foundations carried to rock included the removal of the first floor and all of the old building below it and about 8000 yd. of general excavation down to a depth of about 4 ft. below the old cellar floor. The contractor guaranteed to have all of the new foundations ready to receive the steel superstructure within six weeks after the old building had been razed to the ground, without occasioning any delay or interference with the contractor for the wrecking.

Old Building

The old building was of unusually heavy masonry construction. The lower portion was built without columns, and all of the floors took bearing on the outer walls and on heavy interior walls. The main longitudinal interior wall, 30 in. thick, had a rubble footing 7 ft. wide, and the other interior wall, 28 in. thick, had masonry footings about 4 ft. wide. The concrete cellar floor was about 8 ft. below the curb and was laid directly on the sand, which also received the spread footings of the walls 12 ft. below the curb. The sand stratum extends to the surface of the rock from 20 to 40 ft. below the curb. So far as exposed, the surface of the rock is quite regular, flat and sound. When operations were commenced, water was encountered at a depth of 13½ ft. below the curb.



Driving Piles through Cellar Floor

New Foundations

On the Broadway side of the lot the sand was found firm and stable and could be readily excavated. On the Fifth Avenue side its character was quite different and it closely approached quicksand, flowing readily and making open excavation extremely difficult. This variation of the soil determined the types of pier footings which, when open excavation is practicable, are of solid concrete, built in sheeted pits carried down to rock. In other cases, which were expected to be about one-half of the total number, the foundations are made of groups of Hercules piles—averaging twelve in a group—which are driven to rock and capped with reinforced concrete to receive grillages and bearings for the columns.

The piles are made of single full-length pieces of steel pipe, ⅜ in. thick and 12 in. inside diameter, driven by a 3600-lb. Goubert hammer, excavated by compressed air and filled with 1:2:4 concrete made of ¾-in. gravel and Giant Portland cement mixed in a Ransome machine. The piles are reinforced by full-length 2-in. steel bars, of which there are usually three in each column, thus giving the piles a rated capacity for 82 tons load on each.

Two hydraulic cylinders, 4 ft. in diameter and 18 ft. long, which had been used for the elevator service in the hotel, together with their connected pipes, were utilized by the contractor as receivers for the air compressor, and one of the dynamos and the electric wiring in the cellar were utilized without change for lighting the work.

The locations of the old cross walls and of the principal items of plant installed in the cellar were such that they cleared 30 or 40 per cent of the new piers, permitting their construction to be commenced without interfering in any way with the building or its demolition. This allowed the removal of the old foundations to be postponed until a convenient time without seriously delaying the new foundation work. The old iron water supply tank, 14 ft. in diameter and 10 ft. high, occupied the site of some of the new piers and was cut apart with the oxy-acetylene flame and removed piecemeal while the foundation work was in progress.

Preliminary Operations

While the hotel was still occupied and the cellar kitchen was in service, the contractor drove a 12-in. pipe 30 ft. long through the cellar floor, excavated it and used it as a well from which he pumped continuously 500 gal. of ground water per minute for three weeks. This drainage also facilitated the immediate sinking of a 7 x 7-ft. sheeted foundation pit to a depth of 32 ft. below the street for temporary service as a sump. A 2-in. steam siphon in this sump, operated about one-half of the time, sufficed, with the well pump, to lower the water to an elevation 28 ft. below the curb or nearly 15 ft. below the original position and thus greatly facilitated the excavation of open pits for a number of the foundation piers.

As soon as the foundation forces gained access to portions of the cellar they commenced excavating open foundation pits and as soon as the building was vacated they installed a pneumatic hammer and began driving foundation piles for piers not built in open pits.

The wrecking contractor dumped a large amount of material from upper stories into three 23 x 60-ft. first-story rooms on the Broadway side of the building, and in order to prevent any danger of accident by breaking through the first floor the latter was covered with a solid tier of 6 x 12-in. timbers to receive the impact and carry any load that might be imposed upon it.

PILE FOUNDATION PIERS

For the pile foundations open pits are dug to about 6 ft. below the cellar floor and full-length piles are set up in them and spaced by a horizontal framework of longitudinal and transverse planks spiked together to provide rectangular openings with a slight clearance for each pile. The piles are centered and adjusted in them by wooden wedges driven between them and the planks, and they are maintained vertical while they are driven by the hammer operated by air at a pressure of 150 lb. While in operation the hammer is supported only on the pile, and it is handled by a differential chain hoist suspended from a beam supported on the second floor.

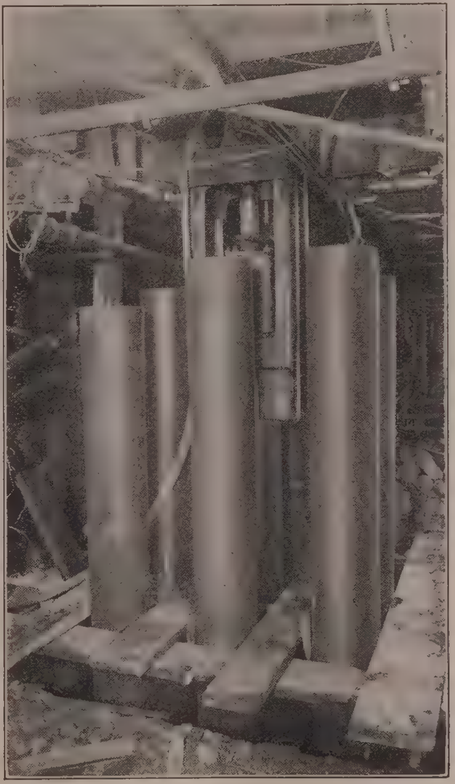
As the length of the piles is much greater than the height of the cellar, rectangular openings are cut through the first floor to permit them to be set and the header beams around these openings are, of course, supported by cellar shoring previously arranged for that purpose. The piles are driven to rock, the interior excavated by compressed air, the rock removed if necessary to a sound hard bearing, and the piles reinforced, concreted, accurately cut off by a ratchet acetylene pile cutter, capped and their tops enclosed in concrete pier footings.

The piers with concrete footings are made in pits about 6 ft. square sheeted with 2-in. vertical square-edge planks or with steel sheeting driven with mauls, as the excavation is made by hand. Owing to the constant operation of the drainage pumps little difficulty is experienced from the ground water.

UNDERPINNING

Several piers with pile foundations are located flush with the lot line at a point where the party wall projects 14 in. inside the line and required underpinning during the pier construction. Three trenches, 3 ft. wide, 4 ft. deep and 6 ft. apart on centers, were dug transverse to the wall and were tunneled under the old footing and about 4 ft. beyond it under the adjoining building. The bottom of each trench was covered with 3-in. transverse grillage planks and on them were laid 12 x 12 in. transverse needlebeams, 18 ft. long, wedged up at the inner end to bearing against the old footing.

A pit 4 ft. 4 in. wide and 10 ft. long, parallel to the wall, was then sunk adjacent to the wall under the needles, and was sheeted down about 15 ft. to ground-water line with horizontal wooden boards. Vertical tongue and groove sheet piling boards were driven from this elevation to rock, the excavation completed and the pier concreted nearly up to the needlebeams which were temporarily supplemented by wooden shoring between them, supporting the wall on the top of the concrete pier until the permanent steel cantilever girders are seated on the piers to carry the steel wall column.



Piles Set in Spacing Frame

In one case when a pier was to be built close to the lot line and the excavation might have caused settlement, narrow excavations were made under the old footing and in them six 12-in. pipes in short vertical sections were jacked down to rock and concreted to underpin a length of about 12 ft. of wall of the adjacent building, thus utilizing the standard Breuchaud method without the usual necessity of recessing the wall.

In several places interior walls were temporarily supported on needlebeams and shores to permit their lower portions to be cut away and afford clearance for new piers. This enabled the new piers to be constructed without waiting for the demolition of the walls which might considerably delay the work.

Wrecking was commenced on March 1 and on the same day the driving of the new foundation piles was begun. On March 25 six of the pile piers and sixteen of the open excavation piers were completed.

Schwartz & Gross are the architects and Lawrence A. Ball is consulting engineer. The foundation work is being executed by the Underpinning & Foundation Company for the Johnson-Kahn Company, owner and builder.

Screening Stone Ballast

Advances Made by the Baltimore & Ohio Railroad in the Last Year in Organizing and Handling This Class of Work

A YEAR ago a discussion of the newly devised system of the Baltimore & Ohio Railroad of using screens for cleaning stone ballast was presented to the American Railway Engineering Association by W. I. Trench, division engineer of the Baltimore & Ohio at Baltimore. An abstract of that discussion, including an illustration of the screens in use, was published in the Engineering Record of April 26, 1913, page 474. During the last year the railroad company has continued the investigation of the system, and a further report was made by Mr. Trench at the recent convention of the American Railway Engineering Association. It will be recalled that the convention accepted the ballast committee's conclusion that stone ballast can be cleaned with screens for approximately half the cost with forks.

Improvements in the screen since the first report include an apron for depositing clean stone on the berm or in the crib at will; a change in the horizontal legs and the pitch of the lower end of the screen so that ballast on the berm is left clear of the ballast line, from which position it can be drawn down against the board with a minimum of labor; a modification of the lower legs so that in yard use, where there is no place to dispose of or leave dirt standing open, it is dropped directly from the screen into sacks and left in the center ditch to the rear to await removal by work train—this change also increasing the speed of the screen by clearing the cleaned ballast behind without the assistance of the shovel. Scoops are also used instead of track shovels in the center ditch and on the berm, as this has been found to increase the speed by a large percentage. Track shovels must be used in the crib, on account of the limited space.

ORGANIZATION OF GANG

After a screen has been evolved which will clean the ballast satisfactorily, says Mr. Trench, the entire problem remaining is to give it such form and so to organize the gang that from the time the dirty ballast is disturbed until the clean ballast reaches its resting place in the track, both stone and dirt progress in an orderly manner, without interference or back movement, and the disposition of the stone is so arranged that the additional stone required occasioned by loss of volume in cleaning can be dumped directly into place from the car without handling. Each member of the gang must have prescribed duties which do not interfere with or depend on any other member of the gang. The pickers, shovelers and dressers have designated and uniform strips of ballast to work over, always moving in the direction of the progress of the gang and using, without exception, one tool only.

Standard organizations have been worked out and costs and rates of progress determined for various classes of ballast-cleaning work. To clean ballast of standard depth and dress it up complete on double track, where the track is not to be raised twelve men beside the foreman are needed, six for the center screen and three for each side screen. One man preceding all others picks for the center screen, which is fed by four, two between tracks and one on each track, the sixth man shoveling out from pan to wheelbarrow and dressing up behind the screen. This center screen is in advance of the side screens, which are at right angles to the track. Each of these has a shoveler at the forward side and another between the rails, the third man dressing the ballast behind the screen and emptying the ballast. The foreman follows in the rear.

With such a squad 200 ft. per 10-hour day are made, the cost per mile being $622. In case the track is to be raised and there is to be no dressing, one man empties the wheelbarrows for both side screens. The same progress can be made, with a reduction to $576 in the cost per mile.

To clean to standard depth on berms and center ditch only, with no cleaning in the cribs and no dressing except a little smoothing up, twelve men and foreman are used as before but distributed differently. As before six men operate the center screen, but the four shovelers are all between the tracks. Two men in advance of each side screen shovel on the screen and a third picks for them and levels the berm after them. The daily rate of progress is 475 ft. and the cost per mile is $262.

In yard work or on line with grassed slopes, where the dirt cannot readily be disposed of, an attachment has been provided in the form of a spout, which delivers the dirt into a common sack. A sheet-iron slide permits shutting off the spout during the exchange of sacks.

In this class of work, cleaning from center to center of adjacent tracks is done with six men and foreman—one picker, four shovelers and one to handle the sacks. The sacks are left in the center ditch to be picked up by work train. Where there are no switches the rate of progress is 475 ft. per day, and the cost per mile $363.

CLEANING BALLAST WITH TIE RENEWALS

Railroads representing a large mileage are requiring that when regular tie renewals are made the ballast in the crib each side of the new tie shall be cleaned. For this purpose one screen is used, equipped with fixtures for use beside the track. Three men operate this screen, ahead of the tie renewals, going only so far as ties will be renewed that day. One man picks on each side of the tie to be taken out and disposes of the dirt from the screen. Two men follow, one shoveling out each crib adjacent to the tie to be removed and throwing the dirty stone on the screen. The dirt is delivered by the screen into a wheelbarrow and the clean stone is caught in the pan at the foot of the screen. This is pulled over the rail and dumped close along the edge of the crib to be filled, and the cleaners proceed to the next crib. The men renewing ties then proceed with the tie renewals, working in pairs, withdrawing the old ties, putting in the new and tamping them. A few trains are allowed to pass over the new tie before it receives its final tamping. The cleaned stone which has been left lying along the edge of the crib is forked into the crib, and the renewal is complete.

Among the advantages of keeping stone ballast clean cited by Mr. Trench are the elimination of semi-annual cleaning of grass and weeds, the saving in cost of new ballast and its application by not raising the tracks, with the consequent saving in cost of widening fill, and the inestimable advantage in increased passenger revenue due to removal of the dust nuisance.

Comparisons of Systems of Flood Control

Fourth Paper in This Series—The Utilization of Flood Prevention Reservoirs for Irrigation, Power Development and Navigation

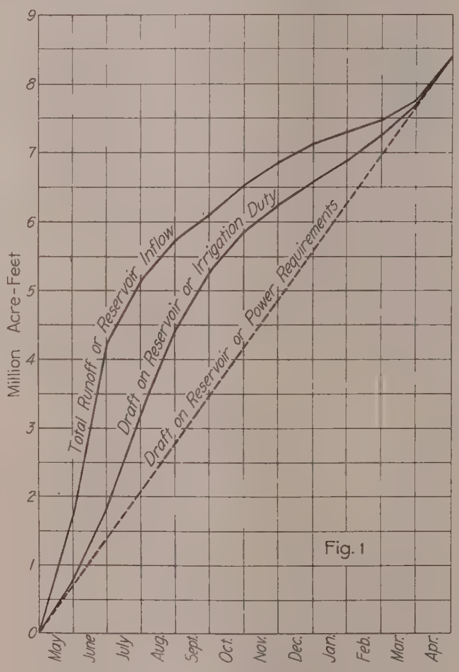
By H. A. PETTERSON
Civil and Hydraulic Engineer, San Francisco

THE purpose of this paper is to compute the storage required for irrigation, power development, navigation and flood prevention, respectively; to determine the storage necessary for flood control in conjunction with the industrial uses cited; to explain in detail the operation of a reservoir serving these interests, and to demonstrate that storage reservoirs, if under governmental control, can be utilized to regulate the runoff from a watershed so that floods will be prevented and other interests served. The drainage basin considered is that of the Colorado River.

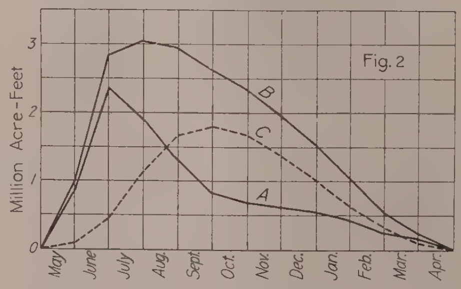
DISCHARGE RECORDS

A ten-years' discharge record of the Colorado River at Laguna dam and the probable minimum yearly flow are given. The minimum yearly flow is important, as it controls the safe water yield for irrigation or power.

Impounding water in years of heavy run-off, to be held over in storage for dry years, is not economically feasible in the arid West, on account of the high rate of evaporation. Even in the eastern United States it is considered best practice to base the reservoir storage on the run-off of the minimum year. (See Rafter's "Hydrology of the State of New York," page 628.) Salient features of the run-off from the Colorado River drainage basin are given in Table 1.



Mass Curves for Minimum Year



Storage Requirements for Minimum Year

A=storage required to insure complete regulation for irrigation; B=storage required for complete regulation of power; C=storage required in secondary reservoirs below power plant for impounding waterwheel discharge and releasing in amounts required for irrigation.

Table 2 contains data on the irrigation duty in the Yuma project of the U. S. Reclamation Service, and the distribution by months of the minimum year's flow, if all used up in irrigation. The 5½ acre-ft. per acre annual duty is from experiments of the Reclamation Service for the Yuma project. Measurements of irrigation water used in the Imperial Valley indicate a much lower duty. It is believed that eventually 2½ acre-ft. will suffice for the irrigation of each acre of these lands. Based upon a 2½-acre-ft. annual duty, the yearly flow of 8,315,500 acre-ft., if completely regulated by storage reservoirs, will irrigate 3,326,200 acres, or practically all of the irrigable area of the Colorado basin. (See Transactions, Am. Soc. C. E. Vol. 76, December, 1913, "Irrigation and River Control—Colorado River," by H. G. Cory; discussion by Francis L. Sellew.) For power development it is assumed that the ultimate development will require complete regulation by reservoirs to produce an average annual flow of 11,500 sec.-ft., equivalent to 100,000 hp per 100 ft. of drop.

Navigation on the Colorado need not be considered, as it has been decided that the interests of irrigation are superior on this stream. The mean flow of the Colorado River is 23,100 sec.-ft. It is proposed to so regulate the runoff in the interests of power development that the minimum flow during any low water season shall not fall below 11,500 sec.-ft., or 50 per cent of the ten-year mean.

The well known method of the mass curve was used to determine the reservoir storage in every instance. The mass curves, covering irrigation and power development, are shown in Figs. 1 and 2. Table 3 contains the same data as Fig. 2, tabulated for more ready reference. It shows the volume of water that must be stored in a reservoir at the end of each month to ensure the flow needed for irrigation and for power development. These storage requirements are the maximum necessary for the purposes mentioned, as it is obvious that in the wetter years the runoff will supply the demand with less aid from the reservoir.

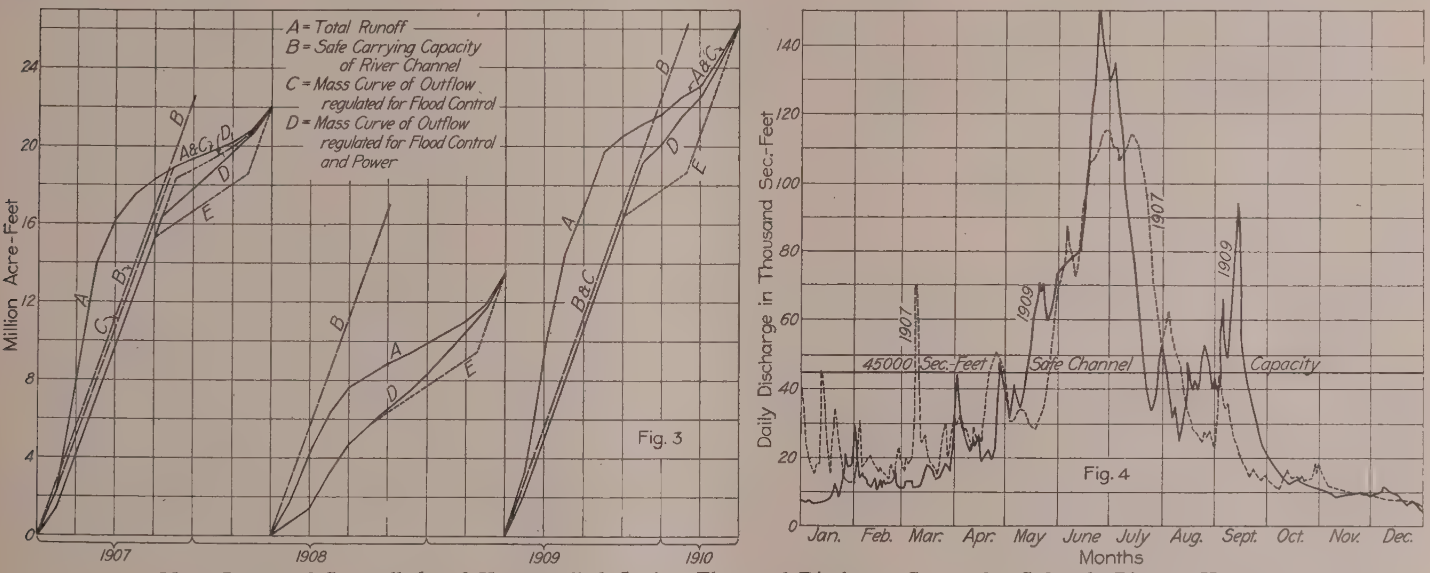
A table similar to Table 3 should be prepared for every watershed tributary to a storage reservoir. Such a table may be called the "operator's schedule." It should be based upon comprehensive engineering studies of the runoff and rainfall. The table is the reservoir tender's order sheet, and it puts the operation of the reservoir on a fixed schedule.

STORAGE FOR FLOOD PREVENTION

A reservoir, operated for the prevention of floods, must hold back enough of the runoff so that the portion going into the stream will flow within its banks. With proper regulation the maximum flow delivered to the stream will be equal to the safe carrying capacity of the river channel. (This question was taken up in the third paper of this series.) The storage capacity of a reservoir for flood prevention is determined from the years with floods of long duration and high stages. The years of 1907 and 1909 are the critical ones for the Colorado River.

Fig. 3 shows the mass curve for the runoff from May 1, 1907, to April 30, 1910. The vertical intercept between the curves *A* and *C* represents the storage required to maintain the river discharge at 45,000 sec.-ft. or less.

The requisite storage for the floods of 1907 and 1909 is approximately equal. The maximum capacity of the reservoir, as determined from Fig. 3, is 6,100,000 acre-ft. A reservoir with this storage, or a series of reservoirs properly located, having an aggregate capacity equal to 6,100,000 acre-ft. will reduce the discharge at Laguna dam to a maximum of 45,000 sec.-ft., which is the assumed discharge at bankful stage. (The carrying capacity of an alluvial stream varies considerably for the same gage height, due to changes in the cross-section of the channel. This is particularly so with the Colorado River. An average capacity of 45,000 per sec.-ft. for a bankful stage at Yuma is used in the ensuing computations.)



Mass Curves of Controlled and Uncontrolled Stream Flow and Discharge Curves for Colorado River at Yuma

Curve *D* in the figure is plotted so that the intercept between *A* and *D* shall not be less than the storage necessary for the needs of the power plants as given in column 2 of Table 3. A line for irrigation, corresponding to curve *D*, was not plotted for fear of causing confusion by too many lines in one diagram. Table 3 and Fig. 2 show clearly that the storage requirements for power development are greater than those for irrigation. Hence a reservoir that will prevent floods and regulate the runoff for power will also have ample storage for irrigation. The maximum intercept between curves *A* and *D* corresponds to a volume of 7,077,000 acre-ft., or only 977,000 acre-ft. greater than the capacity required for flood control alone. This 977,000 acre-ft. is the water that must be impounded in the reservoir at the end of May of every year as shown by Table 3. Table 4 contains the requisite storage capacities of reservoirs for the various purposes considered.

TABLE 1—SALIENT FEATURES OF THE RUN-OFF FROM THE COLORADO RIVER BASIN

	Acre-ft.	Sec.-ft.	Date
Max. yearly discharge	26,100,000	36,000	1908-9
Max. monthly discharge	6,430,000	108,000	June, 1912
Max. 24-hr. daily discharge	296,000	149,500	June, 1909
Min. yearly flow.....	8,315,504	11,500	
Min. monthly discharge	187,000	3,372	Feb., 1903
Min. daily discharge..	....	2,694	Jan. 1903
Av. mean flow (10 years)	16,700,000	23,100	

Ratios of Flow

Max. daily to min. daily........................	55.6
Max. monthly to min. monthly..............	32.0
Max. yearly to min. yearly (absolute minimum)	3.14
Mean yearly to min. yearly..................	2.01
Mean yearly to max. yearly..................	0.64
Regulated minimum flow to absolute minimum	4.27

In Table 4 the last item of 18,100,000 acre-ft. storage for complete uniformity of stream flow was obtained from a mass curve for the full ten-year period. With this storage a theoretical mean flow of 23,100 sec.-ft. could be obtained. The mass curve referred to shows that storage would have to be carried over a period of three years, which, in an arid country, means high evaporation losses. In the Colorado delta this loss is about 6 ft. per annum.

Assume that the hands of time are turned back and that we are with the reservoir keeper on May 1, 1907. The reservoir is practically empty, and, although there was a considerable runoff during the preceding month, the operator's schedule (Table 3) informs him that he can gradually deplete the storage during the month of April and start with an empty reservoir on the first day of May of every year. The reservoir keeper does not know what the runoff will be for the ensuing month, but his schedule tells him to impound 977,000 acre-ft. of water by the end of the month. He sets the discharge gate to allow a uniform outflow of 11,500 sec.-ft. and all inflow in excess of the outflow is automatically conserved.

The runoff during May, 1907, is 2,330,000 acre-ft., while the outflow is approximately 708,000 acre-ft. It is evident, therefore, that the required storage of 977,000 acre-ft. is reached before the end of the month. When this volume of storage has been conserved the keeper regulates the discharge gate so that the outflow will equal the inflow. By the end of May the inflow has begun to exceed the safe carrying capacity of the channel. The sluice gates are adjusted to discharge 45,000 sec.-ft., the maximum allowable. During the months of June and July, the runoff is far in excess of the capacity of the unleveed stream, and the excess is stored in the reservoir.

The inflow averages less than 45,000 sec.-ft. during August, September and October, but the outflow remains at that figure until about Nov. 12, when the runoff impounded during June and July has become depleted to approximately 2,000,000 acre-ft. The schedule informs the reservoir tender that 1,983,000 acre-ft. of storage must be had by the last day of November. From that date until the end of April the volume of water required to be stored gradually decreases until at the end of April the keeper starts a new reservoir year with the basin practically empty, as before explained. Curve *D* shows the rate of outflow if the reservoir is operated strictly according to schedule. The dotted curve *E* shows the probable maximum safe departure from schedule operation. It allows of greater storage during a longer period of time.

A study of Table 3 will show that the storage requirements for industrial purposes are a maximum at the end of June, the month of greatest floods, while it allows of empty reservoirs at the beginning of the flood season, the first of May.

GOVERNMENTAL CONTROL OF RESERVOIRS

On page 24 of the final report of the National Waterways Commission is found the following statement: "A reservoir system, in order to be utilized simultane-

TABLE 2—DUTY OF WATER FOR IRRIGATION AND ITS RELATION TO THE MINIMUM FLOW

	Minimum Discharge		Irrigation Requirements		
			Monthly Duty		Monthly duty using entire flow of min. year,
Month	Acre-ft.	Percentage of annual per cent	Depth, ft.	Percentage of annual per cent	acre-ft.
Jan.	185,407	2.22	0.20	3.64	302,801
Feb.	182,531	2.19	0.25	4.55	378,000
March	367,702	4.43	0.30	5.46	453,500
April	479,663	5.77	0.41	7.45	619,801
May	1,670,000	20.12	0.52	9.45	786,100
June	2,550,000	30.62	0.70	12.71	1,058,100
July	904,476	10.88	0.90	16.37	1,360,700
Aug.	591,480	7.11	0.80	14.55	1,209,500
Sept.	366,948	4.41	0.56	10.17	846,701
Oct.	429,428	5.17	0.38	6.91	574,500
Nov.	321,271	3.86	0.26	4.73	393,150
Dec.	266,598	3.20	0.22	4.00	332,651
Totals ..	8,315,504	100.00	5.50	100.00	8,315,504

ously for flood prevention, aiding navigation and power development, must be controlled or operated by some public authority."

It is this commission's belief that the flood control interest should be predominant. On the other hand, where the hydroelectric interests predominate, it is doubtful if the reservoirs would be operated to prevent floods. The fact has been emphasized that the reservoirs must be empty on the first of May for the runoff shown on curve *A* (Fig. 3).

Now suppose the reservoir operator is in the employ of the power interests. He has been given the operator's schedule, but, as he is working for power companies and not for farmers and cities down the river, he grows rather lax in following the schedule. Suppose that on the first of May, 1909, instead of having an empty reservoir, he has about 3,000,000 acre-ft. of water impounded, through fear that this particular May was going to have a light runoff. Actually, the runoff for May is exceptionally heavy, and gets more severe through June and July. The reservoir is filled to overflowing before the end of June, so that the floods of the latter part of June and early July are moderated only by the mitigating effect of a full reservoir. The necessity for governmental control is, therefore, one of the most important things to keep in mind in the consideration of storage reservoirs for the prevention of floods.

TABLE 3—SHOWING THE RESERVOIR STORAGE REQUIRED AT END OF EACH MONTH TO ENSURE COMPLETE REGULATION FOR POWER DEVELOPMENT AND IRRIGATION UNDER THE CONDITIONS OF THE ABSOLUTE MINIMUM YEAR

	Reservoirs regulated for irrigation only—to supply variable demand shown in last column of Table 2. Acre-ft.	Reservoirs for power only—uniform flow of 11,500 sec.-ft. obtained. Acre-ft.	Additional storage below power plants for combined irrigation and power usage. Acre-ft.
May	883,900	977,040	93,140
June	2,375,800	2,834,080	458,280
July	1,919,576	3,045,596	1,126,020
Aug.	1,301,556	2,944,116	1,642,560
Sept.	821,803	2,618,104	1,796,301
Oct.	676,731	2,354,572	1,677,841
Nov.	604,852	1,982,883	1,378,031
Dec.	538,799	1,556,521	1,017,722
Jan.	421,405	1,048,968	627,563
Feb.	225,936	538,539	312,603
March	140,138	212,281	72,043
April	....	....	....

Note.—For complete regulation of stream flow in the interests of both irrigation and power development, two sets of reservoirs are required. The necessary storage under this condition is given in columns 2 and 3.

TABLE 4—RESERVOIR CAPACITIES FOR VARIOUS PURPOSES

Purpose	Storage capacity, acre-ft.
Irrigation, 2,770,000 acres..............	2,375,800
Power development (average flow 11,500 sec.-ft.)	3,045,600
Irrigation and power.....................	4,841,900
Complete flood control..................	6,100,000
Flood control, irrigation and power......	7,077,000
To obtain complete uniformity of stream flow	18,100,000

This paper would be incomplete without a reference to the temporary storage above the overflow line of a reservoir. This subject has been treated by eminent engineers and a few extracts will be here given. In the report of Col. H. M. Chittenden, investigating reservoirs for the arid regions of the West, is a long discussion on reservoirs: "It is not necessary, though important, that a reservoir should be empty when a flood comes. Even if full, it still moderates the flow of the stream below, the effect varying directly with the superficial area of the reservoir when full, and, inversely with the capacity of the spillway. In this respect it acts precisely as does a natural lake. * * * A large reservoir is, therefore, even when full always a perfect protection against sudden floods. In the case of long continued floods it greatly retards the arrival of maximum effect and gives ample notice of its approach."

Colonel Chittenden cites the case of Lake Geneva, Switzerland, which in area equals only 8 per cent of its watershed, yet in 1856 it reduced an inflow of 56,000 sec.-ft. to an outflow of about 11,400 sec.-ft.

Book Reviews

A report on the regulation of public-service companies in Great Britain has been reprinted from Appendix G of the annual report of the New York Public Service Commission, First District. The report was prepared by Dr. Robert H. Whitten, librarian-statistician, and is the result of six months' special investigation. Such questions as the sliding scale of rates and dividends, the sale of premium shares at auction or by public tender and the audit of company accounts are discussed, and the author strives to show their applicability to American conditions. There are also supplementary chapters on the Boston sliding scale and the Toronto auction sale and maximum dividend plans. (New York, Public Service Commission, First District, State of New York.)

DIE PROFILGESTALTUNG DER UNTERGRUNDBAHNEN. By Dr.-Ing. Anton Macholl. Paper, 6¾ x 9¾ in.; 129 pages; 42 text figures and 2 inserts. Munich and Berlin, R. Oldenbourg. 4.50 Marks net.

This book is written for the purpose of giving the guiding features of the prevailing conditions as bearing upon the selection of the cross-sectional shape of subway tunnels. The illustrating examples are gathered from every city in the world equipped with subways, and the cities of New York, Boston, Philadelphia, London, Glasgow, Berlin, Hamburg, Paris and Buenos Aires are represented. A number of river tunnels, among them that at Detroit, have also been described.

In the introduction the author argues for subways in preference to elevated railways in large cities. The influence of the character of the ground is also briefly touched. Chapter 1, on the shape of tunnel in cross-section, deals with arch-shaped, rectangular (with and without internal columns), and circular tunnels. It begins with an interesting subdivision of the structures into tunnels above water, tunnels partly or wholly in ground water and tunnels under water. Another subdivision is also suggested—tunnels in hard rock, tunnels in hard but deteriorating rock and tunnels in pressure-giving materials.

Materials of construction are the subject of Chapter 2 and brick, brick and concrete, cyclopean masonry, mass concrete and reinforced concrete are discussed as suitable for arched tunnels. Chapter 3 deals with construction and describes the shield method, open construction, use of pneumatic caissons below the tunnel, etc. Chapter 4 contains a tabulated comparison of subways, giving locations, dates inaugurated, descriptions of cross-section, methods of construction and prevailing soil formations, areas of cross-section of excavation, areas of bore, gross areas and shapes of cross-section. Chapter 5 is a comparison of the different types from a statical point of view and Chapter 6 a comparison of costs and their influence on the revenue on the investment.

The book is almost entirely divested of mathematics, the only formulæ given referring to the calculation of a rectangular section without internal columns. It is well written and the illustrations are well chosen. Line drawings only have been used, thus enabling the author to show as many details as possible. The value of the book lies mostly in the classification of the various types of tunnels. The work is the first entirely devoted to the subject of subways.

STEEL BRIDGE DESIGNING. By Melville B. Wells, Associate Professor of Bridge and Structural Engineering, Armour Institute of Technology. Cloth, 6¼ x 9¼ in.; 260 pages; 43 illustrations; 26 plates. Chicago, Myron C. Clark Publishing Company. $2.50 net.

(Reviewed by F. H. Constant, Professor of Structural Engineering, University of Minnesota.)

New books on practical bridge design will, for some time to come, be read with considerable and hopeful interest by instructors in this field. No book can satisfy all needs, yet each instructor hopes that the new work will, at last, fill his particular gap. The present book is, in the first place, not large enough to cover more than a little ground, but it does that very creditably. Of its 260 pages only about half strictly pertain to bridge designing.

The first three chapters give a general view of the subject. They relate to the survey and preliminary work, the organization of the shop and description of the principal tools, inspection and testing, and a brief treatment of riveted joints. Chapters 4 to 10 cover actual design, each chapter giving the detailed numerical computations of the representative example. Thus, Chapter 4 contains the design of a 50-ft. roof truss and roof covering in accordance with the "General Specifications for Structural Work of Buildings," 1910 edition, by C. C. Schneider.

Chapter 5 discusses types and details of highway bridges, and Chapter 6 develops the design of a 133-ft. riveted country highway bridge with beam joists and wooden floor. Cooper's "Specifications for Steel Highway and Electric Railway Bridges," 1909 edition, are used.

Chapter 7 covers types and details of railway bridges and includes a number of text cuts illustrating solid and concrete ballasted floors. Chapter 8 gives the design of a 50-ft. through plate-girder railroad bridge with the ordinary system of floorbeams, stringers and wood ties, in accordance with the American Railway Engineering Association's specifications of 1910, and Cooper's E-55 loading. The chapter includes nine pages of tables and formulæ giving weights of highway, railway and electric-railway steel bridges, for all types of bridges and conditions of loading, from 10 to 400-ft. span. The railway bridge tables are based upon the standard designs of several large railway systems. A valuable and unusual diagram gives the weights of drawbridges on the Illinois Central Railroad for spans of from 75 to 450 feet.

Chapter 9 is concerned with the design of a single-track 130-ft. riveted-truss railroad bridge erected by the Chicago, Milwaukee & St. Paul Railway in accordance with that company's specifications. The joint L_0 and the bottom-chord splice at L_2 are analyzed in detail. The author's analytical processes are logical and sound and it is to be regretted that he did not give more space to joint detail throughout. His aim has been selective, in order to keep the size of the volume down. Repetition of like processes has been avoided, while the characteristics of each type are illustrated in the representative example.

In like manner Chapter 10 illustrates the pin-connected bridge by the design of a 255-ft. single-track through bridge, with curved upper chord, for Cooper's E-50 loading and in accordance with the Chicago, Milwaukee & St. Paul specifications. The principles governing the proportioning of the main members, being similar to those used in the preceding chapters, are not repeated, and only the details of the typical joint are worked out. Chapter 11 gives a few general directions for the making of shop drawings.

The insertion of a chapter (12) on the strength of materials is a little unusual in a book of this character. It is given here for reference and to correct the tendency to use formulæ blindly. The chapter covers centers of gravity, moments of inertia, flexure and deflection of beams, column formulæ (including a rational method of lattice design), combined flexure and direct stress, pins and rollers and the deflection of trusses. It closes with a list of thirty-five of the previously derived formulæ and the accompanying nomenclature.

Chapter 13 gives a concise working bibliography to provide supplementary reading on the subjects treated in the text and should prove to be one of the most valuable features of the book. In Chapter 14 are reproduced the general specifications for steel railway bridges adopted by the American Railway Engineering Association in 1910.

While there are few text cuts, the book concludes with a large number of folded plates of shop and general drawings representing good American practice and from which the examples in the text have been drawn. These plates unfold beyond the margin of the book, making easy reference while reading the text. The book is intended for use as a text in engineering colleges. While its scope is limited to a few simple types it is modern in spirit and representative of current office practice in bridge designing. It should prove a valuable guide to students in designing similar structures.

Letters to the Editor

Tallulah Falls Hydroelectric Plant

SIR: After reading the second article on the Tallulah Falls development, entitled "Highest-Head Hydroelectric Plant East of the Mississippi River," it has occurred to us that a full understanding of the connection of Charles O. Lenz, of 71 Broadway, New York City, with this work might not be gained, and we desire to correct anything misleading by saying that the entire design was carried out under Mr. Lenz as chief engineer and that the construction was also under his direction.

CHARLES G. ADSIT,
Tallulah Falls, Ga. EUGENE LAUCHLI.

Reinforced Concrete and Wooden Telegraph Poles

SIR: I have read with interest the article appearing in your issue of March 21, page 330, regarding the way the reinforced concrete poles along the Pennsylvania Railroad in the vicinity of the New Jersey entrance to the Hudson tunnels stood up during the recent blizzard. I note that the writer of the article in question claims that these concrete poles proved their superiority over wooden poles by the way they stood up. From a careful examination of the photographs accompanying the article I do not believe that justice has been done to the wooden poles. The wooden poles shown in the photographs seem to have been in use for a good many years, and consequently we may assume that they were pretty badly deteriorated and hardly what could be called average poles. Furthermore, they seem to be carrying overloads in many cases without the strain of the snow, sleet and wind of the storm of March 2.

The writer of the article assumes that the poles were carrying sixty telegraph wires in addition to the two telephone cables, having forty pairs of wires of 13 and 16 gage, and a signal control cable. The photographs of the concrete poles, however, show that there were less than forty telegraph wires carried on those poles at the time of the storm.

The article states that the cost of a 40-ft. concrete pole set in the ground was at least $160 per pole. If the average spacing was 120 ft., as given, it would require forty-four poles to the mile, or a total cost of $7,040 per mile for the poles set ready for the cross arms and wires.

I presume that the poles used in these lines were chestnut, with the prices of which I am not familiar, but had these poles been 9-in. top 40-ft. Western red cedar poles, the cost delivered at Hoboken would be a little less than $15 each, and the total cost of the poles set in the line ready for the cross arms and wires would not exceed $22 per pole. These poles, according to tests of the U. S. Forest Service and of private testing laboratories, are mechanically strong enough to take spacing of 120 ft., the same as the concrete pole, thereby giving a cost of $968 per mile as against $7,040 per mile for the concrete poles.

I believe that many of the companies in and around New York City refuse to use larger than a 7-in.-top pole on account of the cost. This of course weakens the pole, and a pole of this kind probably would not stand the strain referred to above.

As I said before, I do not believe that justice was done the wooden poles in this article, and while I have no particular interest in the matter other than from an engineering standpoint, I am taking up the cudgel in defense of the wooden pole, which I consider, after an experience of a good many years, as far superior to the reinforced concrete pole.

One of the strong points in favor of wooden poles as against concrete is that linemen working on concrete poles are always grounded and consequently in a very dangerous position. Any circuit, unless it has been grounded, is not safe to work on when standing on a concrete pole. The fact that the power is shut off or that it is only a telegraph or a telephone wire does not protect the lineman, as it may become alive by another wire coming in contact with it even from a distance of several miles from the point where the lineman is working. This has occurred many times, and would exist in the case of the concrete pole. Furthermore, in cases that have come to my notice where concrete poles have been struck by lightning, they have become practically useless, even though the first indications did not show them to be particularly damaged.

I do not believe it advisable to use concrete poles for distribution systems on account of the first cost, and I believe that this alone would prohibit the use of them in at least 95 per cent of the cases throughout the United States.

J. B. INGERSOLL,
Spokane. Consulting Engineer.

[Mr. Ingersoll states that "the writer of the article mentioned assumes that the poles *were carrying*." . . . The wording in the article is, "Each pole *is designed* to carry." . . . The point regarding the high first cost of the reinforced concrete poles compared with that of wooden poles seems well taken, but the damage done to wooden poles and the line interruption caused by their collapse in one storm like that of March 2 is a strong argument in favor of the more permanent concrete poles. The cost of the Pennsylvania Railroad's poles is high, but these poles were pioneers in the field and were given a large factor of safety. To-day concrete poles can be manufactured at a cost not exceeding that of good wooden poles.—EDITOR.]

Lettering Boundary Lines

SIR: Replying to the inquiry of F. H. Shaw in your issue of March 28, page 376, with regard to the proper direction of lettering survey courses on a plat, I beg to say that in my experience the practice has been uniformly to letter all courses so as to make them easily legible. This requires that horizontal lines, or lines whose inclination is less than 45 deg. to the horizontal, be lettered right side up, while vertical lines and lines whose inclination is more than 45 deg. to the horizontal be lettered upward.

Any scheme of trying to make the lettering follow precisely the direction of the courses would bring some of the lettering into a most inconvenient position for reading. The same holds true where the direction of motion is indicated and lettered on mechanical drawings.

San Francisco. LOUIS ROSS.

SIR: Referring to the proper method of writing the courses upon a traverse which is to accompany a description as questioned by F. H. Shaw in the Engineering Record of March 28, page 376, it seems to me the method to use is the one which permits easiest reading, notwithstanding many variations therefrom by the authorities. This means writing upright, toward the top of the page, and to the left, with each bearing on one side of the line and distance on the other. Inverted writing should be avoided wherever possible.

Chickasha, Okla. E. A. STEECE.

SIR: In your issue of March 28 F. H. Shaw inquires as to the proper method of lettering boundary lines. To the uninitiated it seems that "the proper method," if such were possible, is one in which all data are apparent and easily legible when the map is held in its normal position. To those who have had considerable experience in the use of old plats in the field, however, that method which conveys the greatest amount of information is preferable whether or not its effect is quite so pleasing. The writer has, therefore, found that it is nearly always best so to insert the notes as to show from what direction the survey is made; that is, in all cases make the data on the map correspond directly with the notes as taken in the field and not reversely, as is sometimes done for convenience or effect. It is often very important to know the positive direction taken in a survey, or the beginning and closing points of the several courses, and the method of lettering should be conventional in this respect.

LAURENCE H. MCCULLOUGH.
Kingstree, S. C.

Wye-Level Experiences

SIR: I have had an experience with a wye level that at first was very puzzling. If the level tube was adjusted so that it would reverse when the temperature was 70 deg. Fahr. it would not reverse if tried where the temperature was 30 deg., that is, after the instrument had attained these temperatures.

This fact caused considerable annoyance and the instrument soon was held in disrepute. After thinking the matter over, I concluded that the level tube was not ground to a perfect arc. The inside of the level tube is, I think, intended to be ground to a radius of about 25 ft.; at least, the shifting of the bubble one graduation shifts the cutting point of the crosswires on a card placed 25 ft. from the instrument about 0.1 in., which is the number of graduations per inch of the level tube in question.

To demonstrate that the tube was not of uniform radius, I set the instrument up, erected a card at 50 ft. and made a horizontal center line which was in the line of collimation when the level bubble was at the center of the tube. I then depressed the instrument one graduation on the level tube and marked the point cut by the crosswires. This process was continued, marking the card for every graduation. I next elevated the instrument and used the other half of the level tube, noting all the points cut by the crosswires as before. Practically these points should have been the same distance apart. Theoretically there should be a difference due to the fact that the level moves slightly forward when depressed and slightly backward when elevated. But the results on the card were not so. Those made when using one-half of the level tube and a part of the other half were uniform in spacing, but those for the balance of the other half were much farther apart, thus indicating quite a reduction in the curvature of the level tube.

To come back to the instrument adjustment, when the weather was cool the level bubble was expanded and reached out into that part of the tube where the curvature was more abrupt, and so required a different adjustment of the tube to insure reversing. While the weather was warm the bubble was contracted and was in a part of the tube having a uniform radius. The result was a new level tube and a trustworthy instrument.

While speaking of levels, I will describe an improvement that I improvised when doing some work on spongy ground. My method in running levels is to sight and focus the instrument on the rod and then level exactly before reading the rod. In this particular instance the ground was so spongy or springy that the change in position of the leveler caused the bubble to shift so much that it was necessary to have two men at the instrument, one to adjust and the other to read the rod, neither changing position while making a sight. This, of course, was an exceptional case, but even with ordinary instruments, unless the tripod is extra heavy, there will be a slight shift to the bubble when changing the focus. This is hardly noticeable on long sights, but on short sights the shift is considerable, due to the extraordinary length, or over-hang, of the telescope.

Now for my simple improvement, that can almost be made in the woods, are needed a horizontal rod about the size of a lead pencil, made of brass or steel, a sliding weight of about ½ lb. and two brackets clamped to the bar of the instrument to hold the first mentioned rod and its sliding weight. A small mirror so arranged that the instrument man can see the bubble without moving completes the outfit. After setting up the instrument, level as nicely as possible, point and focus the instrument as usual, and then any slight adjustment after focusing is made by sliding the weight back or forward as may be required. It works well and could be applied by the makers to the convenience of the user.

Columbus, Ohio. S. P. BAIRD.

Wreck of the Attica Bridge

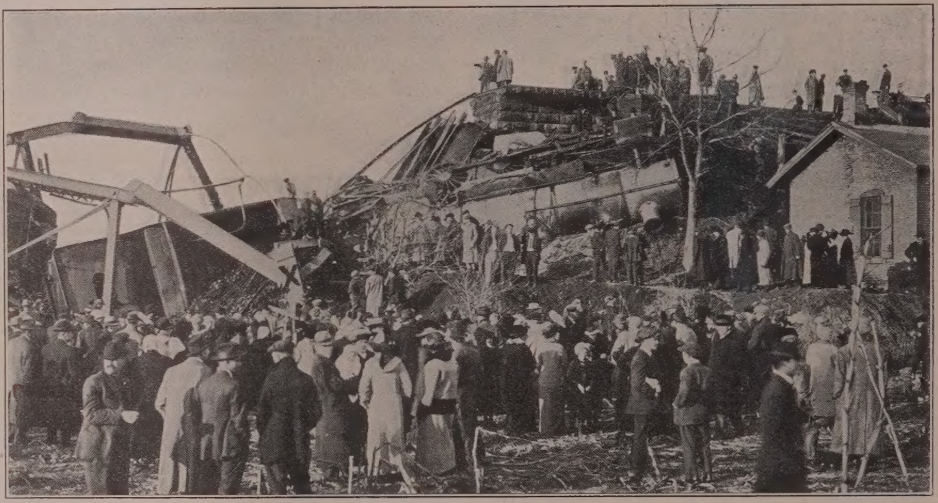
SIR: Many interesting features were brought to light through an investigation of the bridge failure on the Wabash Railroad at Attica, Ind., which occurred about 2 p. m. Sunday, April 5, wrecking two spans, and allowing a passenger engine and three coaches to drop about 30 ft., with the result of only three killed and thirty-five injured, as described in the Engineering Record of April 11, page 223 of the Current News Section.

The bridge was 1795 ft. long, being made up of six Pratt truss spans varying in length from 110 to 156 ft. and twelve deck girder spans each 78 ft. in length, forming an approach on the west. The truss spans spanned the Wabash River, which at this point is about 600 ft. wide.

The failure was a direct result of injuries to the left end post of the east 110-ft. span, which had been struck by a freight car derailed by a curve on the east approach. This car struck the end post with sufficient force to be thrown back upon the ties, along which it bounced for a considerable distance.

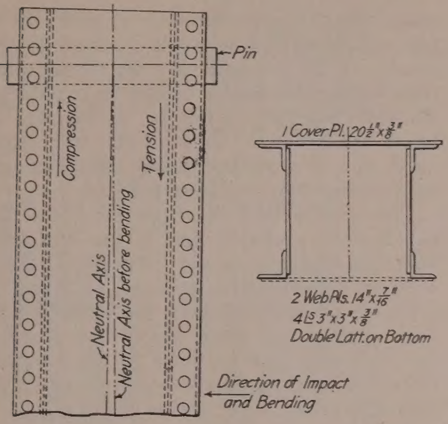
Fortunately a photograph of the injured end post was taken before the failure and from it the elevation was made. This photograph was scaled, and the neutral axis of the end post found to be displaced outwards about 7½ in. The heavy black lines locate splits in the cover plate which were well within the rivet line. Undoubtedly the connection between the floorbeam and the injured end post was severely strained by the lateral bending of the post, although apparently the lower section of the post has remained fixed. Witnesses report that no other injury was apparent.

Following this accident, a freight engine was run across the injured span as a test load, and apparently caused no farther settlement, and the Continental Limited, which was waiting at the other end of the bridge, was allowed to start across. Failure of this end truss occurred when the pilot wheels of the locomotive reached the abutment, which was the position for maximum loading for the injured end post. The locomotive crashed through the injured side of the truss, and turned turtle about 10 ft. down the embankment, stopping the coaches suddenly. The slight momentum of the train, which was moving about four miles per hour, caused the coaches to act horizontally as an arch, and to topple off the structure, carrying with them the second span, 154 ft. long. This is the most interesting part of the failure, as the collapse of the injured end post of the first span was a certainty under the load of a heavy train.


Wreck of First Span, 110 Feet Long, and Overturned Locomotive

Only the first three panels of the second truss collapsed completely, the members of the other three panels still taking stress in so far as they supported their own weight and the weight of a heavy steel coach, between the top of the second pier and the bottom of the river.

A partial analysis of the probable stress in the injured end post at the time of failure gives the following results: The locomotive weighing 421,000 lb. gives a loading approximating Cooper's E-60. With the pilot wheels of the locomotive just off the truss, the shear in the first panel is about 167,000 lb., the dead load being assumed as about 24,000 lb. at each panel point. With a truss height of 26 ft. and a panel length of 22 ft. the stress in the end post is ap-

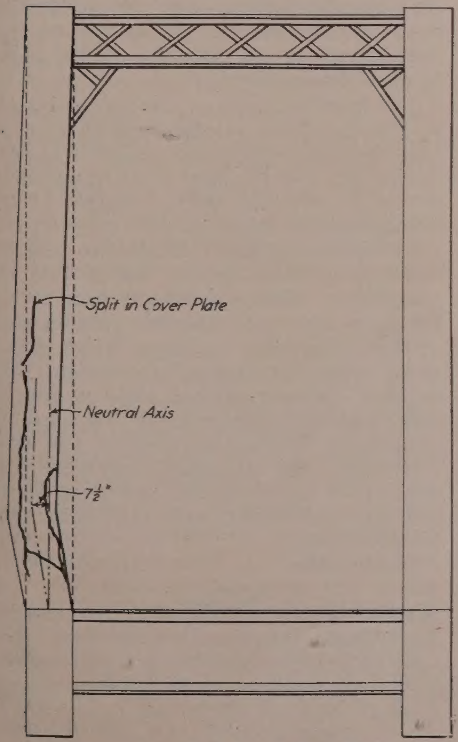


Construction of Injured End Post

proximately 219,000 lb. The section built up as shown in the sketch has an area of 28.36 sq. in. Accordingly, the unit stress in the steel, due to direct compression, was about 7700 lb. per square inch. For a member of this size and length, this stress is very reasonable, but with the cover-plate split and bent in such a manner that the various parts must act as separate members, it is not surprising that the member buckled.

This direct stress of 7700 lb. per square inch is not to be considered excessive when compared with the allowable fiber stress as obtained by the column formula, $P = 16{,}000 - 70 \times l/r$, where l is the length in inches and r is the radius of gyration of the section. Substituting in this formula, $P = 16{,}000 - 70 \times 408/7.1 = 11{,}980$ lb. per square inch, permissible stress.

When the end post bent out of line after the first accident, it is very probable that its end bearing was reduced to the area of the outside plates, with a possibility of tension in the inside plates. If such were the case, a moment couple would be created and the eccentricity of the neutral axis reduced to a negligible quantity. On the other hand, if the bearing areas of the end post remained the same as before the impact of the freight car, the eccentricity of the neutral axis would have caused a moment stress in the steel, which would, in all probability, have aided materially in the failure of the member. So little data on the actual conditions are to be had, that it is impossible to prepare an analysis with any degree of certainty.



Elevation of Injured End Post

If the ends of the post remained fixed in such a way as to allow the eccentricity of 7½ in. to act as a moment arm, an additional moment stress would be set up in the steel. Solving the formula $S = Mv/I$ wherein S is the fiber stress, M is the moment, v the distance to the outermost fiber, and I the moment of inertia about the axis normal to the plane of the bending, a stress of 11,080 lb. per square inch is determined.

This stress is not, in itself, excessive, but when combined with the direct stress, a total compressive stress of 18,780 lb. per square inch must be resisted by the steel in the outermost fibers. This is about 57 per cent in excess of the permissible.

Examination of various members after the failure disclosed many other interesting features. Nearly all compression members failed near pin connections, which shows the importance of tie plates. In compression members made up of channels and lattice bars, the lattice bars often held after the channels had completely buckled and broken. With a very few exceptions, tension members remained effective. Riveting and shop work were of good quality, as were the materials. The bridge was built in 1892 by the Pencoyd Bridge & Construction Company.

Second Span, 154 Feet Long, Wrecked by Coaches Arched Transversely

The manner in which the coaches withstood this violent shock is excellent testimony in favor of modern car construction. Fortunately all coaches were steel throughout, which no doubt aided materially in keeping the number of dead and injured so low. The construction of a temporary timber structure was begun at once and rushed along as rapidly as possible, with the expectation of relieving traffic within a few days.

La Fayette, Ind. J. E. MASON.

Comparisons of Systems of Flood Control

SIR: In the Engineering Record of April 4, page 391, there appears under the caption "Comparisons of Systems of Flood Control," the first of a series of papers on the subject, by H. A. Petterson, civil and hydraulic engineer. The writer feels impelled to notice some of the statements put forth in the above paper. In the first place, the author appears to possess meager knowledge concerning the physiography and hydraulics of the lower Mississippi River, which has led him to place this main trunk of a colossal drainage system in the same category with all the small rivers throughout the country, in its relations to the subject of flood control. To put it mildly, this seems wholly unwarranted. The author evidently regards restraining reservoirs as the panacea for flood problems, and while the writer is not disposed to challenge his argument as to the application of the reservoir system to relatively small rivers and limited areas, he is convinced that no practicable system of restraining reservoirs can appreciably modify the great floods of the lower Mississippi valley and that reliance on such a recourse is worse than futile.

There is one vital factor that enters into this problem which seems to have been ignored by the reservoir advocates, and that is the relative combined drainage areas of all the projected or suggested reservoir sites, as compared with the whole extent of the Mississippi River drainage basin.

The total area of the watershed of the Mississippi River drainage system is given by the authorities as 2,240,000 sq. miles. The question is, whether the aggregate area of territory upon which the run off is to be arrested or restrained by all the reservoir projects in contemplation shall constitute an appreciable proportion of the entire drainage basin, for the purposes of this discussion. The water to be withheld from the lower Mississippi floods must be measured in terms of the drainage area eliminated by the reservoirs and not by the cubic feet of water contained in them.

It is the conviction of the writer that the combined effect of all the reservoirs that may be economically practicable, and which could be brought into action during any particular flood period, would not be sufficient to justify reliance on such a recourse for controlling the floods in the lower Mississippi valley. It is doubtless true that reservoirs can be introduced, and may be economically justified, in controlling local floods involving limited areas, as in the Miami valley in the vicinity of Dayton, Ohio. It is at least suggestive to consider the estimated cost of that project in its relation to the area on which the runoff is expected to be arrested or delayed. The estimated cost of the flood controlling works in the

Miami valley is $17,000,000. The total drainage area tributary to the projected reservoirs is given as 2650 sq. miles, or about one-tenth of one per cent of the whole drainage territory of the Mississippi River.

If it is assumed that reservoir sites can be selected which in the aggregate shall restrain the runoff on one-tenth of the entire basin, of which about 25 per cent only might be expected to come into action in one individual flood, the total cost, reckoned on the Miami basis, would amount to $1,700,000,000. This presentation of the matter is of course merely suggestive, but is nevertheless full of significance.

Mr. Petterson returns to the exploded idea that flood restraining reservoirs can be utilized to afford water for irrigation and for power purposes, in spite of the obvious fact that a reservoir, if kept full, cannot restrain flood water, and when empty cannot afford water for the above purposes of utility. Reservoirs designed to restrain floods in the lower Mississippi must be confined to that single function and the two questions arise, whether an expansive development of such a system for controlling floods would be economically practicable, or whether it would serve the intended purpose if so developed.

The only practicable site for a reservoir to serve the purpose of modifying flood conditions in the lower Mississippi valley is the channel of the river itself, where a relatively moderate expenditure of money, applied to raising and enlarging the two lines of existing restraining levees on opposite sides of the river would so far increase its holding capacity as to obviate all dangers of overflow upon the protected lands.

Mr. Petterson asserts that pumping must be resorted to wherever lands are protected from inundation by levees. Apparently he does not realize that all the storm water that falls near the lower Mississippi flows away from the river and not into it, and there is no occasion for any pumping to free the lands from water, as it runs off by gravity. Bank revetment, however, is an essential factor in flood control, as stability of the caving banks, to prevent portions of the levees from being engulfed by the river, is a fundamental necessity to the effectiveness of levee protection.

Clarksdale, Miss. T. G. DABNEY.

The Fetish of Formulæ

SIR: It is only too often that we hear the accusation that formulæ derived from theoretical considerations are unduly applied to the practical design of structures. This is mostly advanced by people who call themselves engineers, but are unable to grasp the meaning of the theories of mechanics.

A letter in the Engineering Record of Feb. 21, 1914, entitled, "The Fetish of Formulæ" is a striking example of this unjust accusation. With the data given by the writer, David Gutman, the compression per square foot of foundation at the rock line was 51,250 lb. for the caisson 4 ft. wide, concentrically loaded, whereas the maximum intensity of the pressure for the foundation 6 ft. wide and eccentrically loaded would have been 66,000 lb. Now if 25 tons were specified as a maximum stress in the foundation, the engineers who objected to the 6-ft. caisson eccentrically loaded were certainly right.

Mr. Gutman supports his point of view by saying that "had the caisson been 10 ft. wide the case would have been worse, and had it been a mile wide it could have been proved to be rotating like a Fourth of July pinwheel." This statement is entirely incorrect, as everybody who has studied mechanics knows that in case no tension can be developed at the base of the foundation, the compressive stress cannot exceed the value $2P/3g$, where P denotes the total load and g the distance of the resultant from the nearest edge of the foundation. Therefore the stress, if the resultant cuts outside the middle third, is independent of the width of the foundation. If tension can be developed, the stress never reaches even this amount.

EUGENE E. HALMOS, C.E.
New York City.

SIR: In your issue of Feb. 21, 1914, two valuable columns are occupied by a letter on eccentric connnections and loadings, in which the writer tries to disprove the theory of eccentric connection by citing an eccentrically loaded caisson 6 ft. wide with column load 1 ft. off center. Horse sense says, "The more the stronger," but the simplest mechanics proves that for a caisson 4 ft. wide the pressure is uniform, 1,000,000 lb. per foot of width, plus the weight of the concrete, while with the given caisson it varies from zero to 1,333,333 lb. per foot of width, plus a uniform load for the concrete. Hence the latter is only 75 per cent as strong as the former, and it is not surprising that the two competent engineers objected.

Furthermore, widening the caisson to 10 ft. or a mile will not cause it to spin like a pinwheel, but will gradually make it safer by moving the resultant further from the edge. The pressure will be distributed over a width three times the distance from the edge to the resultant of the column and caisson loads.

Chicago. G. A. HEINRICH.

Conditions of Railway Employment

SIR: In your issue of April 4 you ask editorially the question, "What is the matter with the railway engineering departments?" The answer is partly to be found in the preceding editorial, entitled "Railroad Retrenchment." Efficiency in such departments can only be reached by continuous service, with opportunity for advancement sufficient to justify the individual remaining indefinitely. Nearly every railway system has certain distinct characteristics, even if only in the form of management, policy and financial ability to carry out works of additions and betterments. It is necessary for the railway engineer early to become familiar with the policy of the company he may happen to connect himself with, in order that he may be most useful to that company.

Ability to design elaborate structures, exemplifying the best of practice, and employing the most expensive materials, but which the road cannot afford, is not as useful as ability to utilize materials at hand in smaller and less pretentious structures which the road can afford. The policy of the company may not be just what the engineer would choose himself, but he must necessarily adapt himself to that policy, and do the best he can. Promotion usually follows in proportion as the engineer accepts the ideas of the management and gains more and more the confidence of the higher officials. At this stage he is not only most useful to the company, but his position enables him to grasp a broader significance of his work, and his deep-felt interest in and loyalty to the company are worth far more than mere cold-blooded technical knowledge. As the years of service go by he gets to know the road as he does his own backyard, and dreams and plans improvements long before they are ever fulfilled.

The trouble with the rank and file of the department probably lies in the fact that only the higher few get in personal touch with the management, and too often, during a period of retrenchment, men are laid off just at a time when they have become familiar with and adjusted to their duties. Others voluntarily leave because the situation offers nothing of a permanent value.

Such a man usually enters the service at the bottom at a salary perhaps in keeping with a beginner. But if that beginner is a technically trained man and plunges into the work with the zeal and interest born of a novel experience he soon becomes worth more. There is, however, nothing for him to do but wait for a vacancy in the next higher position, which too often is itself nothing great to look forward to, compared with other occupations. Or he may get side-tracked as a supervisor—a position to which the laborer looks forward with favor, but which to the sensitive, educated, capable engineer is a sort of purgatory. Only by a turn of fortune will he receive an office commensurate with his ability. The outlook proves discouraging, and so, just as his value to the company is at flood-tide, he is forced to leave to better himself.

Thus the department is stripped of some of its most valuable men. The chiefs usually remain, and some others, who would "rather bear those ills they have than fly to others that they know not of." But it is more often the fascination of railroad work and the intense loyalty and a sort of proprietorship in the welfare of the company, coupled sometimes with personal kindness and sympathy of associates, that prompt these to stay, rather than any pecuniary attractions. Retrenchments probably have the worst effect. Sometimes the chiefs themselves only manage to stem the flood through the painful duty of discharging their loyal assistants. These are the men that constitute the splendid ability found in these departments.

The trouble seems to be a combination of circumstances. It might seem to some that the engineer is a born martyr to such conditions. But the same could be remedied, partly, at least, by more foresight of the management in balancing their expenditures for maintenance and construction, and the injection of more human feeling into the operations. Managements are prone to follow long-established customs, whether good or bad. The organized labor unions gain a great many advantages by coercion. The average engineer neither could nor would care to resort to that method. He takes the hazards of the position and is too often underpaid, and it is not unnatural that complaints are frequent and from every quarter, that loyalty and sacrifice have no better reward.

Mobile, Ala. L. W. DUFFEE.

POWDER CHARGES used in grading work on the Canadian Northern Railroad in British Columbia are said to have given best results when varied from a minimum of ½ lb. of powder per cubic yard of shale to a maximum of 1⅓ lb. per cubic yard of hardest country rock.